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MERRIMACK RIVER, MASS. AND N. H.

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L E T T E R

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORTS ON PRELIMINARY EXAMINATION AND SURVEY OF THE MERRIMACK RIVER, MASS., FROM LOWELL TO THE SEA, AND ON PRELIMINARY EXAMINATION OF MERRIMACK RIVER, FROM LOWELL, MASS., TO MANCHESTER, N. H.

W. C. Ingalls

JANUARY 2, 1917.—Referred to the Committee on Rivers and Harbors and ordered to be printed, with illustrations.

WAR DEPARTMENT,
Washington, December 22, 1916.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers, United States Army, of yesterday's date, with reports on preliminary examination and survey of Merrimack River, Mass., from Lowell to the sea, and preliminary examination of Merrimack River from Lowell to Manchester, N. H.

Very respectfully,

NEWTON D. BAKER,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, December 21, 1916.

From: The Chief of Engineers, United States Army.

To: The Secretary of War.

Subject: Preliminary examination and survey of Merrimack River, Mass and N. H.

1. There are submitted herewith, for transmission to Congress, report dated March 29, 1913, by Col. F. V. Abbot, Corps of Engineers, and report dated November 10, 1914, with maps, by Lieut. Col.

W. E. Craighill, Corps of Engineers, on preliminary examination and survey, respectively, authorized by the river and harbor act approved July 25, 1912, of Merrimack River, Mass., with a view to securing increased depth from Lowell to the sea or in any part of this section of the river, together with a supplemental report on this subject by Col. Craighill, dated October 22, 1915. There is also submitted herewith report dated March 25, 1916, by Col. Craighill, on preliminary examination authorized by the river and harbor act approved March 4, 1915, of Merrimack River, from Lowell, Mass., to Manchester, N. H. On account of the close relationship of the two investigations, it is deemed advisable to print these reports in one document.

2. This stream is formed by the confluence of the Pemigewasset and Winnepesaukee Rivers at Franklin, N. H., from which point to its mouth is a distance of about 110 miles. Hunts Falls, at Lowell, the upper end of the proposed improvement, is about 38 miles from the sea. The harbor of Newburyport, at the mouth, is being improved under a project providing for a permanent channel through the outer bar 1,000 feet wide and at least 17 feet deep at mean low water, to be secured by the construction of two jetties, with dredging if found advisable. The total expenditures to June 30, 1915, amounted to \$174,248.74, and the project was then about 97 per cent completed. The existing project for improvement of the Merrimack River, adopted by the act of March 3, 1899, provides for obtaining a channel 7 feet deep at mean low water, 150 feet wide, from Newburyport to the railroad bridge at Haverhill, a distance of $16\frac{1}{2}$ miles, at an estimated cost of \$171,442.70. Under present and previous projects for the river the expenditures to June 30, 1915, amounted to \$404,268.80, making a total of \$578,517.54 expended on Merrimack River and Newburyport Harbor. The mean tidal range is 7.9 feet at the mouth and 4.6 feet at Haverhill. The depths now available at mean low water are 13 feet through the bar at the mouth up to Black Rocks beacon, thence about 9 feet to Newburyport, thence at least 14 feet to a point locally known as the Lions Mouth, and thence at least 7 feet to the railroad bridge at Haverhill, which is situated about $20\frac{1}{2}$ miles from the bar. Above the Haverhill railroad bridge the channel is shallow, narrow, and tortuous, and is not navigated.

3. By an act approved June 20, 1914, the Legislature of the State of Massachusetts appropriated the sum of \$1,000,000 "for the improvement for navigation of the Merrimack River from the sea to Hunts Falls at Lowell, by the construction of a channel therein: *Provided*, That no part of said sum shall be available or expended until the Congress of the United States shall approve a project, and make an appropriation therefor, to improve that part of said river from the sea to a point opposite Ward Hill, about one mile above Haverhill, so that a continuous channel will be provided throughout this part of said river not less than eighteen feet deep at mean low water and of adequate width." The Merrimack Valley Waterway Board has submitted an estimate of the cost of extending the channel about 15.3 miles from Ward Hill to Hunts Falls, Lowell, amounting to \$5,443,600, exclusive of land damages and bridge removal, new bridges, alterations, etc. The district officer gives consideration

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to several methods of improvement to secure a channel 18 feet deep and 200 feet wide from the mouth to Ward Hill. The plan suggested as most economical provides for the excavation of a tidal channel from Black Rocks Beacon to Lions Mouth, construction of lock and dam at Lions Mouth, and excavation of channel above dam to Ward Hill, all at an estimated cost of \$2,750,000. The district officer is of opinion that no additional improvement at the bar is necessary at present. The construction of the dam at Lions Mouth will render unnecessary the dam at Mitchells Falls and the lock at Ward Hill, as proposed by the Merrimack Valley Waterway Board, thus reducing the estimate of cost to \$4,326,600, for work from Ward Hill to Hunts Falls, making a total estimate for the entire project of \$7,076,600, not including the cost of necessary terminal and transfer facilities, changes in bridges and power plants, etc.

4. The commerce now carried by water on the improved stretch between Haverhill and Newburyport averages about 100,000 tons per year, consisting mostly of coal, on which there is reported to be a saving of from 35 to 50 cents per ton on the cost of carriage by rail. The total inward and outward commerce of Lowell, Lawrence, and Haverhill has been estimated by the Merrimack Valley Waterway Board as about 5,000,000 tons annually. The proportion of this commerce which would follow the improved waterway can not, of course, be predetermined, being dependent in a large measure upon the disposition of local interests to utilize the new route in preference to existing rail facilities. The district officer reaches the conclusion that the benefits to be expected are so uncertain, and the physical difficulties, and consequently the cost, are so great that the improvement should not be undertaken by the General Government. The division engineer believes that the improvement might be justified under certain conditions of State cooperation.

5. There is now no water-borne commerce on the section of river between Lowell and Manchester, a distance of about 35 miles, and as the work would be very expensive the district officer is of opinion that this part of the river is not worthy of improvement by the United States under present conditions for the reason that the benefits to be expected would not be commensurate with the cost involved. The division engineer concurs in this view.

6. These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its reports herewith, dated May 23, 1916, and June 6, 1916. The board concurs with the district officer and the division engineer in the opinion that it is not advisable for the United States to undertake the improvement of the river between Lowell and Manchester. With reference to the project from Black Rocks Beacon to Hunts Falls, near Lowell, which is estimated to cost \$7,076,600, and for which the State has appropriated \$1,000,000, the board is of opinion that the proposed Federal expenditure of the balance, amounting to approximately \$6,000,000, would not be warranted by the resulting benefits to the general public. It believes, however, that the interests to be affected are of sufficient magnitude to justify the United States in entering upon this project on a more equitable basis of cooperation. If the improvement be undertaken it should be carried to Hunts Falls and executed as one project by the United States. In

the opinion of the board it is advisable for the United States to undertake the improvement at a total estimated cost of \$7,076,600, substantially in accordance with the plans proposed by the district officer and the Merrimack Valley Waterway Board, subject to such modifications in the details of the plans as may be found advisable by the Chief of Engineers during the progress of the work, the United States to pay one-half of this first cost and assume subsequent maintenance, care, and operation, and the State or other local interests to pay one-half of the first cost and assume all responsibility for cost of rights of way, flowage claims, bridge alterations, and damages to existing water power or other interests, provided that the work be not commenced until assurance satisfactory to the Secretary of War has been given that the State of Massachusetts or local interests are prepared to cooperate on this basis.

7. After consideration of the above-mentioned reports it seemed to me that certain features of the case were not adequately presented, and I therefore called upon the district officer for a further statement, which is transmitted herewith, covering the additional work that may be necessary to enable barges drawing 17 feet to cross the bar at the mouth of the river during all conditions of weather, the probable loss to water-power interests on account of the consumption of the water at the Lawrence Lock, and the probability of boats of suitable draft for the proposed channel remaining in service in sufficient numbers to accommodate the large traffic that is expected. A depth of 23 and 25 feet on the bar will probably be necessary in stormy weather for barges drawing 17 feet. It is impracticable to state in advance how much dredging will be required annually to remove the littoral drift that will tend to shoal this channel, but it is believed that the expense of this work will not exceed the district officer's estimate of \$80,000. The consumption of water in lockage apparently will not have an important bearing on the proposition, as the maximum loss to the power interests from this cause in the driest year is estimated not to exceed \$3,000. While it appears from the responses made to inquiries of shipping concerns that there is a marked tendency to increase the size and draft of seagoing vessels, there seems to be reasonable assurance that there will continue to be a sufficient demand for barges not exceeding 17 feet in draft to keep a large number of such boats in service.

8. After due consideration of the available data, I concur with the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors in the opinion that it is not advisable at the present time for the United States to undertake the improvement of Merrimack River from Lowell, Mass., to Manchester, N. H. I concur with the Board of Engineers for Rivers and Harbors in the opinion that the improvement by the United States of Merrimack River, Mass., with a view to securing increased depth from Lowell to the sea, or in any part of this section of the river, is advisable to the extent of providing a channel 18 feet deep at mean low water and 200 feet wide from Black Rocks Beacon to Hunts Falls, at an estimated cost of \$7,076,600, the State of Massachusetts or other local interests to contribute 50 per cent of the first cost of the improvement and to undertake further cooperation, as recommended by the board and specified above, and further to the extent of providing a

channel 1,000 feet wide and not less than 23 feet deep across the bar at the mouth of the river at the expense of the United States and at a cost estimated not to exceed \$80,000 a year. The first appropriation by the United States should be \$1,000,000 and subsequent appropriations made so as to complete the work in four years, and funds to be furnished by the State or local interests should be made available at the same rate.

W. M. BLACK,
Chief of Engineers, United States Army.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
LOWELL TO THE SEA.

[Sixth indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
June 6, 1916.

The CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. The following is in review of the district officer's reports authorized by the river and harbor act of July 25, 1912, on preliminary examination and survey of Merrimack River, Mass., with a view to securing increased depth from Lowell to the sea, or any part of this section of the river:

2. The Merrimack River, formed by the confluence of the Pemigewasset and Winnepesaukee Rivers at Franklin, N. H., enters the State of Massachusetts a short distance above Lowell and empties into the Atlantic Ocean about $2\frac{1}{2}$ miles below Newburyport, Mass. It is navigable for commercial uses up to Haverhill, about 19 miles above the mouth. Above Haverhill the slope is steep and the river is used for water power, the first dam being at Lawrence and the second at Lowell.

3. There are two projects now in effect. (a) Newburyport Harbor, Mass., adopted by the act of June 14, 1880, and extended by the act of June 25, 1910, provides for a channel over the outer bar 1,000 feet wide and at least 17 feet deep at mean low water, to be secured by converging jetties supplemented by dredging, if found advisable, at an estimated cost of \$599,547.49. The mean tidal range is 7.6 feet to 7.9 feet. The total amount expended to June 30, 1915, was \$474,248.74. The project is reported as about 97 per cent completed. (b) Merrimack River, Mass., adopted by the act of March 3, 1899, provides for a channel 7 feet deep at mean low water, 150 feet wide from Newburyport to the railroad bridge at Haverhill, $16\frac{1}{2}$ miles, at an estimated cost of \$171,442.70. The mean tidal range is 7.9 feet at the mouth and 4.6 feet at Haverhill. The project has been completed. The amount expended to June 30, 1915, was \$115,424.77 for new work and \$34,377.31 for maintenance, a total of \$149,802.08.

4. Investigations in connection with the preliminary examination indicated that the United States would not be justified in undertaking the improvement of the entire reach from Lowell to the sea, but that it might be advisable to give greater depth up to Ward Hill, about 2 miles above Haverhill, if the Commonwealth of Massachusetts would make a similar improvement between Ward Hill and

Lowell. The survey by the United States to Ward Hill was therefore conditioned upon the State making a survey and project from Ward Hill to Lowell. This condition was met and a plan prepared by the Merrimack Valley Waterway Board. This plan proposes a lock at Ward Hill at the upper end of the proposed United States channel, another lock at the existing Lawrence Dam, a dam at Mitchells Falls, and dredging a channel 18 feet deep and 200 feet wide from Ward Hill to Hunts Falls, about 2 miles below the Pawtucket Dam at Lowell. The estimated cost of this project is \$5,443,600. An act of the State legislature approved June 20, 1914, and subsequently reenacted appropriates \$1,000,000 for the improvement of the river from the sea to Hunts Falls at Lowell, provided the United States adopt a project and make an appropriation to improve that part of the river from the sea to Ward Hill.

5. The survey and estimates by the United States were based upon securing a channel 200 feet wide and 18 feet deep at mean low water from the sea to Ward Hill, except across the bar at the mouth, where there is now a depth of only 13 feet, but the conditions here are improving since the recent extension of the north jetty, and the district officer considers nothing further needed than work already authorized under the 17-foot project. The estimated cost of a tidal channel 21 miles long from Black Rocks beacon inside the bar to Ward Hill is \$8,500,000. In view of this large cost estimates were prepared for a project involving a tidal channel up to Lions Mouth, $3\frac{3}{4}$ miles above Newburyport, with a lock and dam at that place forming a pool practically to the dam at Lawrence. This would raise the water surface 12.71 feet, which would make it possible to dispense with the lock at Ward Hill and dam at Mitchells Falls proposed by the State board at a cost of \$1,117,000. The estimate for carrying 18 feet to Ward Hill on this basis is \$2,750,000. The district officer states that the use of a dam at Lions Mouth is objectionable on account of the probable bad effect on the maintenance of the channel over the bar, as it would cut off about two-thirds of the tidal flow of the river. Another objection is the ponding of sewage in the pool formed by the dam. Under this plan the estimate for the improvement up to Hunts Falls becomes:

Channel to Ward Hill with lock and dam at Lions Mouth.....	\$2, 750, 000
Channel from Ward Hill to Hunts Falls, Lowell.....	4, 326, 600
Total	7, 076, 600

This estimate does not include terminals, changes in bridges and power plants, and flowage rights. The district officer places the grand total at about \$10,000,000.

6. Statistics furnished by the Merrimack Valley Waterway Board show the population of the Merrimack River cities to be 307,540, invested capital \$188,152,336, annual wages paid \$42,004,459, value of product \$196,595,077, consumption of coal 1,200,000 tons, of which about 135,000 tons are now received by water. It is given as the opinion of the manufacturers along the river that an adequate water route would effect a saving in freight rates of from 50 cents to \$1 a ton. The district officer states that the statistics of his office show a total of about 100,000 tons of freight received and shipped at Haverhill, the head of existing navigation; that it is problematical

how much would be carried by water if facilities were provided; and that while many would undoubtedly derive great benefit, the actual water-borne commerce would be disappointing in not showing a profitable investment. In view of the large cost and uncertain results, the district officer is of opinion that it is not advisable for the United States to undertake the improvement. The division engineer believes the improvement might be justified under certain conditions of State cooperation.

7. Interested parties were informed of the unfavorable views of the district officer, and at their request a hearing was given at this office on May 23, 1916, which was attended by Hon. J. J. Rogers, M. C.; Hon. M. F. Phelan, M. C.; and a delegation from the localities.

8. The section of country adjacent to the head of the proposed improvement, including the cities of Haverhill, Lawrence, and Lowell, is densely populated and is a manufacturing center of great importance. Large quantities of raw materials are brought in and converted into finished products of great value in the aggregate. The principal item of commerce in bulk is coal, of which it is estimated about 1,200,000 tons are used annually, and it is largely on the anticipated saving in the freight rate on this commodity that local interests look for justification for the desired improvement, although there are many other items of commerce, including cotton, hides, wool, iron, lumber, and the finished products of the mills, that would be benefited, but to a less degree.

9. That the improvement would be of advantage to a large community and would result in material benefits seems beyond doubt. The amount of this benefit expressed in terms of dollars and cents is impossible of definite determination. The information available indicates that the annual saving on coal alone would be between 23 cents a ton, or \$230,000, as estimated by the one opponent of the improvement, and 50 cents to \$1 per ton, or \$500,000 to \$1,000,000, as estimated by proponents. In addition to the receipt of coal, which would probably be handled in cargo lots direct from middle Atlantic ports, there should develop a large traffic in other articles between Boston and the Merrimack cities. It seems reasonable to believe that a regular boat line would be put on between these points and it should do a large business.

10. An important factor entering into this consideration in addition to the question of saving in freight rates is the known rail congestion and car shortage that are experienced from time to time. An additional transportation route not subject to these disturbances would be of great advantage to the community.

11. The improvement from Black Rock Beacon to Hunts Falls is estimated to cost \$7,076,600, with probably \$100,000 annually for maintenance. This is in addition to the cost of providing terminals, flowage rights, bridge alterations, etc. Of this sum the State proposes to contribute \$1,000,000, leaving approximately \$6,000,000 to be paid by the United States. In the opinion of the board the resulting benefits to the general public would not warrant this Federal expenditure. It believes, however, that the interests to be affected are of sufficient magnitude to justify the United States in entering upon this project on a more equitable basis of cooperation. If the improvement is undertaken at all, it should be carried to Hunts Falls

and executed as one project by the United States, and in the opinion of the board the basis of cooperation for actual construction, at an estimated cost of \$7,076,600, should be 50 per cent by the State or other local interests and 50 per cent by the United States, the local interests also assuming all other items of expense not included in this estimate. The board therefore recommends that the United States undertake the improvement of the Merrimack River from Black Rock Beacon to Hunts Falls, at an estimated cost of \$7,076,600, substantially in accordance with the plans proposed by the district officer and the Merrimack Valley Waterway Board, subject to such modifications in the details of the plans as may be found advisable by the Chief of Engineers during the progress of the work, the United States to pay one-half of this first cost and assume subsequent maintenance, care, and operation, the State or other local interests to pay one-half of the first cost and assume all responsibility for cost of rights of way, flowage claims, bridge alterations, and damages to existing water power or other interests, provided that the work be not commenced until assurance satisfactory to the Secretary of War has been given that the State or local interests are prepared to cooperate on this basis. The first appropriation by the United States should be \$1,000,000, and subsequent appropriations made so as to complete the work in four years. Funds to be furnished by the State or local interests should be at the same rate.

12. In compliance with law, the board reports that, except as contemplated by the above recommendations, there are no questions of terminal facilities, water power, or other subjects so related to the project proposed that they may be coordinated therewith to lessen the cost and compensate the Government for expenditures made in the interests of navigation.

For the board.

FREDERIC V. ABBOT,
Colonel, Corps of Engineers,
Senior Member of the Board.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
LOWELL TO MANCHESTER.

[Third indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
May 23, 1916.

The CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. The following is in review of the district officer's report authorized by the river and harbor act of March 4, 1915, on preliminary examination of Merrimack River, from Lowell, Mass., to Manchester, N. H.

2. A report, published in this same document and submitted under the river and harbor act of July 25, 1912, on the Merrimack River from its mouth to Lowell, considers a channel to be obtained by dredging and by locks and dams, 18 feet deep and about 38 miles long, terminating at its upper end at Hunts Falls, about 2 miles below Lowell. The present investigation contemplates an extension of this 18-foot channel from Hunts Falls to Manchester, a distance

of about 35 miles. The improvement would reach two cities of importance—Nashua, N. H., population about 26,000, and Manchester, N. H., population about 70,000.

3. This section of the river is at present navigable only for small boats in the pool of the Pawtucket Dam at Lowell. A small canal around the dam through the city of Lowell affords a passageway for small boats, but it is rarely, if ever, used at present. Several plans for carrying the desired 18-foot channel from Hunts Falls into the Pawtucket Dam pool are described by the district officer, any one of which would involve extensive rock excavation in connection with lock and canal construction. From the head of the Lowell pool to Manchester the channel is rocky and obstructed by shoals and rapids. To overcome the rise of about 31 feet on this section two locks and dams would be required. It appears possible to create some water power in connection with one or both of these dams, but the value of such power would be small compared with the cost of the improvement.

4. There is, of course, under existing conditions no water-borne commerce, and the amount that would use the waterway if made navigable is purely conjectural. The water traffic would apparently consist almost entirely of materials received, of which coal would constitute the larger part. The district officer describes the present routing of this commodity and current rates, from which it appears that no great saving would result from the improvement. The district officer expresses the opinion that under present conditions the Merrimack River from Lowell to Manchester is not worthy of improvement by the United States. The division engineer concurs in this view.

5. Interested parties were informed of the unfavorable report of the district officer and given an opportunity of presenting their views, and on May 23, 1916, a hearing was given at the office of the board on this subject in connection with a report on the Merrimack River from Lowell to the sea, submitted under authority of the river and harbor act of July 25, 1912.

6. It is evident, from the information now before the board, that the improvement desired on this section of the Merrimack River would be very expensive. In addition to much rock excavation and the construction of several locks, it would require the reconstruction of a number of bridges and would probably interfere with existing water power. Moreover, there is no apparent urgent need for the improvement. The principal commerce to be affected would apparently consist of coal and building materials. The local delivery of these commodities is now organized on the basis of rail transportation and a change to the water route would involve considerable terminal and rehandling charges. It does not appear that the saving in freight rates would be at all commensurate with the cost of the improvement. In view of these conditions, the board concurs with the district officer and the division engineer and reports that in its opinion it is not advisable for the United States to undertake the improvement of the Merrimack River from Lowell, Mass., to Manchester, N. H., either as an independent improvement or in connection with that of the lower river.

7. In compliance with law, the board reports that there are no questions of terminal facilities, water power, or other related sub-

jects which could be coordinated with the suggested improvement in such manner as to render the work advisable in the interests of commerce and navigation.

For the board.

FREDERIC V. ABBOT,
Colonel, Corps of Engineers, Senior Member of the Board.

PRELIMINARY EXAMINATION OF MERRIMACK RIVER, LOWELL TO
THE SEA.

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
Boston, Mass., March 29, 1913.

From: The District Engineer Officer.

To: The Chief of Engineers, United States Army
(Through the Division Engineer).

Subject: Preliminary examination of Merrimack River, Mass.

1. In compliance with instructions contained in a letter, dated August 3, 1912, and with provisions of the river and harbor act approved July 25, 1912, the following report is submitted on the preliminary examination of Merrimack River, Mass., with a view to securing increased depth from Lowell to the sea or in any part of this section of the river.

2. *Work already done.*—On October 31, 1867, Mr. Henry Mitchell, assistant United States Coast Survey, submitted a report in which he described a survey, made under his direction by Mr. H. L. Marindin, covering Mitchells Upper and Lower Falls and Hazeltine Rapids. He placed the upper limit of tidal oscillation in the lower part of the upper falls; he stated that the river “can be made navigable for barges drawing 4 feet without locks or other expensive structures. After the requisite depths are obtained by excavations, the single difficulty is the strong currents at the rapids.” He found velocities of 6.6 miles per hour “in the lower center” of the lower falls at low water and only 2.5 miles per hour at high; at the upper falls 4 miles per hour at low water and 5.5 miles per hour at high were found near the foot of the falls. (H. Ex. Doc. No. 25, 41st Cong., 2d sess.) On August 16, 1869, Gen. J. G. Foster submitted an estimate amounting to \$74,887.50 for removing the obstructions at the upper and lower falls, Gangway Rock at Newburyport, wreck of a coal vessel near the mouth of the river, some rocks locally known as “The Boilers” near the city wharves, and for contingencies. In 1870, 1871, and 1872 appropriations aggregating \$75,000 were made by Congress, and Gangway Rock was removed to give a mean low water depth of 9½ feet, the wreck was removed, and work was begun and about half completed at the lower falls.

In August and September, 1872, the river was surveyed by Lieut. James B. Quinn, Corps of Engineers, acting under the orders of Lieut. Col. George Thom, Corps of Engineers, who reported that the river could be improved “to permit vessels of 20-foot draft to ascend to Amesbury Ferry and vessels of 11-foot draft thence up to Haverhill” for \$19,000; also that “nearly 200 vessels, varying from 75 to 400 tons each, passed up the Merrimack for Salisbury, Amesbury,

and Haverhill.” (Annual Report of Chief of Engineers for 1873, p. 77.)

In the Annual Report of the Chief of Engineers for 1877, page 36, it is reported that—

All the work projected for improving the falls of this river above Haverhill, Mass., has been completed to the extent now deemed necessary. Newburyport Harbor, at the mouth of the river, has also been improved by the removal of South Gangway Rock and of a wrecked schooner, and some progress has been made in the removal of North Gangway Rock.

Between Newburyport and Haverhill the river has been improved by deepening the shoals and the removal of numerous bowlders which obstructed the channel * * *. This work has all been completed except the removal of numerous sunken bowlders from the channel near Silsbys Island, for which the funds now available are sufficient.

For completing all the work now projected for the improvement of Newburyport Harbor the additional sum of \$25,000 will be required.

At that time appropriations aggregating \$122,000 had been made by Congress for Merrimack River and Newburyport Harbor jointly in the river and harbor acts of 1870, 1871, 1872, 1873, 1874, and 1875.

In the Annual Report of the Chief of Engineers for 1882 it is stated:

Previous to July 1, 1881, the work done for the improvement of this river consisted in opening the channel above Haverhill and through “The Falls” to the projected width and depth in places where absolutely necessary to make its navigation practicable; also in dredging at Haverhill between the bridges and at Silsbys Island Shoals, as well as at Curriers Shoal (about 4 miles below Haverhill), and at Rocks Bridge ($6\frac{3}{4}$ miles below Haverhill), including the removal of a large number of dangerous sunken rocks at and near Rocks Bridge and the head of Silsbys Island; also in Newburyport Harbor in the removal of Gangway Rock and partial removal of North Rocks and in the removal from the channel of several sunken wrecks and piers.

Appropriations, including the river and harbor acts from 1870 to 1882, inclusive, aggregate \$167,000. This annual report contains also the preliminary examination of Merrimack River by Col. George Thom, Corps of Engineers, from Lawrence to Manchester, N. H., called for by the river and harbor act of March 3, 1881. The estimate (p. 541) was as follows:

Mitchells Falls to lower lock at Lawrence, $4\frac{1}{2}$ -foot depth	\$11, 000
Lawrence Dam to Pawtucket Dam at Lowell, 4-foot depth	225, 000
Pawtucket Dam to Nashua, N. H., removing bowlders	8, 000
Nashua, N. H., to Manchester, N. H., 3-foot depth	304, 000
Total	548, 000

This project was not adopted by Congress.

In the Annual Report of the Chief of Engineers for 1885 it is stated that—

The channel from the mouth to the head of the Upper Falls has been completed in accordance with the adopted project. The excess of expenditure over the original estimate in the execution of this work is \$15,670.09. This excess is explained by the fact that about \$16,000 have been expended in the removal of rocks and other obstructions whose existence was unknown or whose removal was not contemplated when the original estimate was made.

Additional work was recommended in this report, \$11,500 from the mouth to the head of the falls and \$11,000 from that point to the city of Lawrence, about 29 miles from the mouth.

In the Annual Report of the Chief of Engineers for 1888 it is reported:

The improved channel is in good order and meets all existing demands of commerce. No appropriation is recommended for the fiscal year ending June 30, 1890.

The appropriations from 1870 to June 30, 1888, inclusive, aggregate \$170,500.

In the Annual Report of the Chief of Engineers for 1894 it is stated that—

At the date of this report the project for the improvement of the river is completed and the improved channel is in good order. * * *

No increase of the tonnage of the river is apparent since the improvement was commenced, and no new lines of water transportation have been established.

Appropriations, including the river and harbor act of July 13, 1892, aggregate \$242,366.72, including \$60,366.72 carried by the acts of 1828, 1830, 1831, 1833, and 1834, taken up in the Annual Report of the Chief of Engineers for 1892.

The river and harbor act of August 17, 1894, directed the Secretary of War "to make a resurvey of said river with a view of obtaining a depth up to Haverhill equal to that over the bar at Newburyport."

Under date of January 15, 1896, Lieut. Col. S. M. Mansfield, Corps of Engineers, submitted the report called for by the above legislation. The estimate covered a channel 200 feet wide from the sea to Newburyport and 150 feet wide thence to Haverhill; the depth was 12 feet at mean low water, the estimated cost was \$1,496,851.07, and the length of the channel was about 20 miles, of which $9\frac{1}{2}$ only required improvement. (Annual Report of the Chief of Engineers, 1896, pp. 617-618.)

The river and harbor act of June 3, 1896, ordered an estimate "of the cost of improving the Merrimack River, Mass., by dredging the channel thereof between Newburyport and Haverhill of the width of 150 feet and of the depth of 7 feet at mean low water." The report dated May 5, 1897, on this survey is printed on page 865, Annual Report of the Chief of Engineers for 1897; the estimated cost of the improvement was \$171,442.70. The river and harbor act of March 3, 1899, adopted this new project and provided \$40,000 for initiation of work thereunder. In the Annual Report of the Chief of Engineers for 1903 it is stated that 52,000 tons of coal used the river route in 1899, 60,000 tons in 1900, 60,000 in 1901, and 29,901 in 1902.

The river and harbor act approved June 13, 1902, authorized a preliminary examination with a view to obtaining a depth of 9 feet to Haverhill. The report on this examination by Lieut. Col. W. S. Stanton, Corps of Engineers, is printed in the Annual Report of the Chief of Engineers for 1904, page 873, and was adverse, on the ground—

that the small barges, carrying 500 to 600 tons, with a draft of 10 to 11 feet, are going out of use, and that larger barges, carrying 1,500 or 1,600 to 2,000 tons, with the draft of 15 or 16 to 18 feet, are supplanting them. * * *

So by the time the improvement to the depth of 9 feet would be completed there seems to be little probability that it would enable coastwise coal-carrying vessels to ascend to Haverhill or that it would materially cheapen the cost of the water carriage of coal to that city.

By June 30, 1905, the 7-foot channel was completed up to the highway bridge at Haverhill. The commerce in 1904, 76,527 tons, was reported to have increased 25 per cent over the prior three years; in 1905 it was 88,324 tons; on page 43, Annual Report of the Chief of Engineers for 1906, it is reported that the delivery of coal by water to river points ran 35 to 50 cents less per ton than by rail.

The river and harbor act of March 3, 1905, contained an item ordering "an examination to be made with a view to providing a channel 12 feet deep between the mouth of the river and the falls above the city of Haverhill, also including in such examination rocks and other obstructions at the mouth of said river." The report of Col. W. S. Stanton, Corps of Engineers, was adverse to the 12-foot channel on the ground that—

"providing a channel 12 feet deep between the mouth of the river and the falls above the city of Haverhill" would not enable coal to be carried through it in ocean-going barges, would not, in my opinion, be of benefit commensurate with its cost, and is not worthy to be made by the United States.

Dredging and the removal of certain ledges were recommended in the report on the survey, the estimated cost being \$62,000. (*See* H. Doc. No. 339, 59th Cong., 2d sess.) This project was never adopted by Congress.

The river and harbor act of March 2, 1907, called for a preliminary examination and survey of Merrimack River, Mass., "with a view to providing by locks and dams a channel 14 feet deep from the mouth of the river to the railroad bridge at Haverhill." The favorable report of Lieut. Col. Edward Burr, Corps of Engineers, on this survey is contained in House Document No. 2, Sixty-first Congress, second session. The estimated cost was \$890,000. The action of the War Department was unfavorable to the execution of the project, and it has not been adopted by Congress.

In the Annual Report of the Chief of Engineers for 1909 it is stated: "The project" (of 1897, for 7 feet to Haverhill) "having been completed, it is proposed to apply the appropriation recommended to the maintenance of the improved channel." Since that time all work has been maintenance. Appropriations to date aggregate \$405,366.72; the balance unexpended on March 1, 1913, was \$11,501.98.

3. *Navigable extent and maximum draft that can now be carried at mean low water.*—The mouth of the Merrimack is 54 miles north of Boston. The bar has been improved by two jetties, about 12 feet being now available at mean low water; in smooth weather this affords safe entrance at high tide to coal barges drawing in the vicinity of 17 feet. Three and a half miles above the bar is Newburyport, a city of about 15,000 inhabitants. Between the bar and Newburyport, for depths exceeding $9\frac{1}{2}$ feet at mean low water, the channel is obstructed by rocks and by a middle-ground shoal with a limiting depth of 10 feet at that stage of tide. With these exceptions, 12 feet can be carried safely at mean low tide in the natural channel to a point about half a mile above the mouth of Powow River and about 8 miles from the ocean bar. A channel at least 150 feet wide and 7 feet deep at mean low water has been dredged from the upper end of the 12-foot natural channel to the railroad bridge at Haverhill, a distance of approximately 12 miles, that bridge being

about $16\frac{1}{2}$ miles from Newburyport. Above the railroad bridge the natural channel has a depth of something like 8 feet and a width varying between 50 feet and 250 feet for about 1 mile, and for the next 1,500 feet, to the foot of Hazeltine Rapids, a depth of perhaps 3 feet to 6 feet (see H. Doc. No. 339, 59th Cong.; 2d sess., p. 3), obstructed by bowlders. When making the present preliminary examination it was hard to find anyone willing to risk taking a naphtha boat drawing a couple of feet to the foot of Hazeltine Rapids. There seemed to be no one who knew where the channel was or what obstructions were likely to be met. From Hazeltine Rapids to Lawrence the river is now abandoned by navigation, and people along the banks believe that the 4-foot channel 60 feet wide formerly excavated through the lower and upper falls has been filled with bowlders. Above the Lawrence Dam for about 7 miles up to Richardsons Brook backwater gives gentle current and sufficient depth for naphtha boats drawing 2 or 3 feet; thence to Lowell there is no navigation, but an examination of the river was made from the banks. Great numbers of bowlders were visible. Between Lowell and the sea neither snags nor overhanging trees impede navigation.

4. *Rise and fall of water surface.*—At any point below Mitchells Upper Falls the elevation of the water surface is dependent at any given time upon four factors—two natural and two purely artificial. They are the tidal stage at the mouth, the natural discharge in the river and its tributaries, the effect upon that discharge of the operation of the mills at Lowell and Lawrence, and the withdrawal for sanitary uses of water from the Nashua and Sudbury Rivers, formerly all tributary to the Merrimack. The withdrawal of water is controlled by the Metropolitan Water and Sewerage Board charged with the sanitary service of Boston and of the towns lying within the metropolitan water district. The amount withdrawn for sanitary purposes does not vary greatly with the season of the year, but is a constantly increasing draft upon the discharge formerly available for navigation purposes. It varies with the population resident in the metropolitan district. In the nontidal part of the river the effect of the mills is a maximum at the time of low water, for then they use the pools above the dams for pondage. While the mills are shut down they store water for use during the hours when they are in operation, thus reducing to nothing the discharge immediately below the dams. In discussing this pondage Mr. C. W. Thom, of Haverhill, said at the hearing on October 4, 1912:

I don't want to say anything against Lowell and Lawrence. I suppose they are looking after themselves and must protect themselves. But I did not know there was any such law that allowed them to absolutely stop the flow of this river. I suppose they have so little water that they have to. But for the last three or four years, I have been motoring up here for the last few years, and I have seen the river absolutely cut in two at Lowell and Lawrence; not one drop. The flow absolutely stopped. Dams and canals are all right if they will let it go around and over and give us a flow down there. That would be all right. But if it was not for the protection of the tide we would have nothing there. Every week we would have absolutely nothing but mud flats, and we have not much more than that there now. It is something awful there, the stench of the mud.

As the dams were built under State legislation before the United States assumed jurisdiction in such matters, the legal situation is one which is likely to give trouble if there be an attempt on the part.

of the United States to insist in the interests of navigation on the natural flow of the river. Judging from the current literature in connection with the Chicago Drainage Canal, there seems to be equal or greater question as to any United States regulation of the amount withdrawn from the river by the Metropolitan Water and Sewerage Board.

Below Mitchells Upper Falls the river is essentially a tidal stream during the greater part of the year, with the characteristics, during that period, of such a stream. Taking mean low water at Black Rocks Beacon, close to the ocean, as the plane of reference, the following tidal data are available:

Location.	Date of obser- vation.	Distance above Black Rocks Beacon.	Approximate slope from each point to next point below—		Mean low water.	Mean high water.
			At low water.	At high water.		
		<i>Feet.</i>			<i>Feet.</i>	<i>Feet.</i>
Pacific Mills tailrace, Lawrence.....	1881	150,000	$\frac{155}{400,000}$	No tide...	16.04	(1)
Lower locks, Lawrence.....		146,000	$\frac{283}{2700,000}$	No tide...	14.49	(1)
Mitchells Falls (head).....	1881	119,000	$\frac{752}{2200,000}$	No tide...	11.66	(1)
Haverhill Bridge.....	1905	97,000	$\frac{36}{1700,000}$	$\frac{-2}{1700,000}$	4.14	8.72
Groveland Bridge.....	1903	82,000	$\frac{92}{2100,000}$	$\frac{21}{2100,000}$	3.78	8.74
Rocks Bridge.....	1903	61,000	$\frac{162}{2900,000}$	$\frac{25}{2900,000}$	2.86	8.53
Powow River (mouth of).....	1903	32,000	$\frac{74}{1900,000}$	$\frac{20}{1900,000}$	1.24	8.28
Newburyport.....	1895	13,000	$\frac{50}{1300,000}$	$\frac{40}{1300,000}$	.50	8.08
Black Rocks Beacon.....	1880	0	.....	.....	.00	7.68

¹ Mean low water with mill water running.

The regimen of the river is shown by the following table, showing the monthly mean stage at the Lawrence lower locks gauge for 63 years, referred to a datum plane 9.01 feet above mean low water at Black Rocks Beacon; no Sunday readings recorded.

Year.	Jan- uary.	Feb- ruary.	March.	April.	May.	June.	July.	Aug- ust.	Sep- tem- ber.	Octo- ber.	No- vem- ber.	De- cem- ber.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1850.....	7.70	9.67	9.24	11.81	15.26	9.56	7.56	7.42	8.42	6.85	6.78	7.89
1851.....	7.54	11.35	9.68	12.19	9.27	7.02	6.22	5.64	4.50	5.17	8.90	7.24
1852.....	9.86	9.11	10.32	15.07	11.50	6.50	5.05	4.96	5.54	5.58	7.99	8.64
1853.....	7.89	10.93	10.01	11.12	9.96	6.80	4.87	6.20	6.43	7.76	10.39	7.04
1854.....	8.91	8.74	10.97	12.21	13.76	7.08	5.46	4.82	5.11	4.86	8.40	8.02
1855.....	10.07	12.11	7.92	14.51	9.24	8.48	6.99	6.30	5.13	9.67	8.48	8.23
1856.....	8.66	8.02	7.77	12.23	9.67	7.08	5.21	9.34	7.45	7.22	6.71	8.04
1857.....	8.01	12.73	8.99	13.21	12.72	8.62	6.66	7.90	6.47	7.68	8.49	8.60
1858.....	9.01	7.26	8.04	8.72	9.13	7.73	6.01	6.35	7.47	7.50	7.92	6.65
1859.....	8.69	9.15	13.88	12.46	10.30	8.42	6.45	5.67	6.03	6.13	6.64	7.88
1860.....	7.93	8.22	9.82	7.97	6.22	6.80	6.16	6.78	7.84	7.42	9.65	7.40
1861.....	8.90	11.78	12.58	14.08	11.33	7.47	5.95	5.74	5.14	6.50	7.98	8.15
1862.....	7.60	7.31	9.41	14.48	10.40	7.32	6.88	6.16	5.78	5.69	7.93	7.33
1863.....	7.76	8.94	8.71	14.97	10.05	6.24	7.58	8.13	7.01	8.48	10.30	9.46
1864.....	10.52	8.32	11.51	11.84	10.18	6.27	5.12	5.21	4.90	5.90	8.27	8.08
1865.....	9.37	8.14	13.52	11.59	11.49	6.98	6.39	5.58	5.33	5.66	6.81	6.22
1866.....	6.37	10.49	8.64	10.29	7.65	8.54	6.29	6.68	7.04	6.56	8.77	8.60
1867.....	8.19	11.07	7.96	13.30	11.12	8.47	6.65	9.31	6.76	6.59	7.38	7.52
1868.....	7.63	7.61	10.77	10.61	12.63	9.78	5.83	6.03	9.16	7.74	10.01	7.96
1869.....	8.75	8.53	9.46	16.09	11.23	7.65	6.73	5.93	6.02	12.26	8.40	9.31
1870.....	12.36	10.50	9.48	18.28	9.91	6.82	5.98	5.72	5.51	5.59	5.66	6.09
1871.....	6.51	7.41	10.02	8.90	9.50	6.46	5.63	5.61	5.63	6.26	8.00	7.64
1872.....	7.49	6.65	6.58	12.02	8.69	9.07	6.66	8.43	8.79	8.67	9.92	8.07
1873.....	10.04	9.19	8.46	15.13	11.22	6.34	5.64	5.62	5.96	8.99	7.57	8.37
1874.....	10.65	10.11	9.22	9.51	12.26	9.44	9.28	6.92	5.78	5.76	5.37	6.06
1875.....	6.49	7.32	9.39	12.94	9.94	6.98	5.61	6.13	5.49	6.10	8.53	7.17
1876.....	7.51	7.99	11.85	14.09	11.61	7.53	5.56	5.44	5.44	5.37	6.21	6.02
1877.....	6.90	6.79	11.03	11.67	8.27	6.19	6.37	6.83	5.63	7.25	9.86	8.71
1878.....	8.57	9.25	11.70	11.26	10.22	7.21	5.61	6.76	5.64	5.74	7.72	12.54

Year.	Jan- uary.	Feb- ruary.	March.	April.	May.	June.	July.	Au- gust.	Sep- tem- ber.	Octo- ber.	No- vem- ber.	De- cem- ber.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1879.....	8.54	9.84	9.27	12.83	10.73	7.89	6.41	6.54	6.30	5.54	6.71	8.16
1880.....	8.31	9.87	9.37	9.44	7.24	6.09	5.90	5.67	5.43	5.23	6.76	6.11
1881.....	6.94	8.64	11.99	11.04	10.39	7.05	6.17	5.79	5.52	5.55	7.26	8.40
1882.....	8.92	10.23	11.36	9.47	9.52	9.07	5.76	5.29	6.30	5.85	5.31	5.68
1883.....	6.21	7.06	7.35	11.40	8.85	7.20	6.08	5.33	4.65	5.15	5.67	5.84
1884.....	7.99	9.78	11.30	14.34	9.92	6.43	5.33	5.18	5.33	4.94	5.38	6.99
1885.....	9.06	8.72	7.60	11.95	8.63	6.50	5.62	7.10	5.77	5.81	8.93	7.93
1886.....	10.83	12.40	9.97	13.23	8.07	5.95	5.29	5.27	5.25	5.24	7.72	7.63
1887.....	10.55	10.83	8.94	14.21	10.62	8.39	7.90	8.78	6.73	6.14	6.77	7.90
1888.....	9.23	10.15	10.47	14.76	13.55	7.50	5.54	5.65	7.80	10.57	10.93	11.50
1889.....	10.41	7.96	10.00	9.92	8.05	7.45	6.35	7.14	6.12	7.65	9.12	10.76
1890.....	8.66	9.18	11.54	12.31	11.31	8.35	5.95	6.07	8.64	10.06	9.02	7.81
1891.....	11.30	10.91	14.43	13.74	8.30	6.83	5.90	5.55	5.60	5.33	5.58	6.47
1892.....	9.53	7.20	8.28	8.54	9.52	7.59	6.88	6.52	6.55	5.52	7.74	6.58
1893.....	7.10	8.65	10.10	12.00	13.08	6.91	5.41	5.12	5.34	6.25	6.19	7.53
1894.....	7.26	7.63	10.63	9.59	7.81	7.35	5.44	4.76	5.35	5.50	6.26	6.13
1895.....	6.61	6.52	7.76	13.13	7.72	5.85	5.71	5.36	5.29	6.42	9.35	9.29
1896.....	8.97	9.05	13.49	12.61	6.84	6.31	4.82	5.00	5.76	7.15	7.77	7.23
1897.....	6.67	7.64	9.66	12.22	9.43	10.27	9.69	7.30	5.62	5.48	7.96	9.76
1898.....	8.53	9.68	12.67	11.72	9.98	8.36	5.38	6.36	5.83	7.86	9.40	9.22
1899.....	9.14	8.11	10.53	15.37	9.24	5.84	5.82	5.57	5.41	5.39	5.74	5.93
1900.....	6.56	11.68	11.89	13.01	9.72	6.60	5.28	5.07	5.05	5.79	7.47	8.29
1901.....	6.19	6.16	9.08	15.39	12.01	8.46	5.85	6.91	5.98	6.76	6.02	9.40
1902.....	10.05	7.90	15.16	12.28	9.66	7.53	6.69	6.50	6.36	8.91	7.88	9.30
1903.....	9.03	9.68	15.51	11.31	6.52	9.39	7.02	5.97	5.43	6.49	6.15	6.45
1904.....	6.73	7.03	10.15	13.17	11.85	6.81	5.78	5.75	5.92	6.38	5.91	5.39
1905.....	7.66	6.45	8.96	11.39	7.30	6.64	5.92	5.92	8.79	6.13	6.35	7.71
1906.....	8.61	6.86	8.40	12.21	9.85	10.22	7.39	6.16	5.58	5.66	6.23	6.01
1907.....	8.02	6.98	8.02	10.87	9.14	7.26	6.24	5.46	6.32	8.89	11.16	9.59
1908.....	9.24	8.80	10.55	10.69	10.30	6.73	5.65	5.98	5.23	5.09	5.10	5.28
1909.....	6.16	8.16	9.01	12.82	9.48	6.85	5.86	5.45	5.09	5.52	5.32	5.80
1910.....	7.10	7.26	12.11	9.92	8.00	7.20	5.12	5.34	5.21	4.93	5.31	4.97
1911.....	6.06	5.66	7.25	10.70	7.42	5.64	4.70	4.95	5.27	6.67	7.27	8.05
1912.....	7.42	6.78	9.90	12.82	9.65	7.18	5.27	5.79	5.69	6.08	7.48	7.26
Mean, 63 years.	8.35+	8.79+	10.15+	12.27+	9.91+	7.43+	6.10+	6.16+	6.06+	6.61+	7.59+	7.70+
Mean discharge in cubic feet per second....	7,264	8,273	11,585	17,602	10,936	5,260	3,460	3,520	3,420	4,054	5,580	5,820

The above table shows that for many months each year the fresh water discharge in the nontidal part of the river is so small that an open channel of sufficient capacity for coastwise steamers and barges, desired by all who appeared at the hearing, would have an almost negligible slope and current.

Freshet conditions are unusual except in the spring. The highest of record in the last 50 years occurred in March, 1896, the maximum stages reached, referred to the plane of mean low water at Black Rocks Beacon, were as follows:

	Feet.
Powow River at high tide.....	17.68
Powow River at low tide.....	¹ 13.00
Merrimacport	20.22
Rocks Bridge	20.86
Groveland Bridge	21.73
Haverhill Bridge.....	23.93
Lower lock, Lawrence.....	38.79
Above dam, Lawrence (crest of dam is elevation 43.13).....	52.99

Photographs (Appendix F)² show that at the time of this freshet the dam at Lawrence was nearly drowned out, although its crest is at reference 43.13; low water at the lower locks is at reference 14.49,

¹ Or less.

² Not printed.

both referred to mean low water at Black Rocks Beacon. Immediately below the dam the river gorge was so constricted by the erection of factory buildings that it was insufficient for the discharge, and on both banks water rose over a foot deep in the operating rooms of the mills. In the following table taken from page 9 of Col. Burr's report of November 3, 1908 (H. Doc. No. 2, 61st Cong., 1st sess.), data are given as to other floods which have occurred:

Freshet Heights at Lawrence referred to Black Rocks Datum.

	Pool above dam.	At lower locks.		Pool above dam.	At lower locks.
	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
1852, Apr. 23.....	53.12	37.92	1873, Oct. 22.....	49.26	27.49
1864, Mar. 7.....	52.01	-----	1874, Jan. 10.....	49.91	30.13
1869, Oct. 6.....	51.71	33.26	1875, Apr. 6.....	50.80	30.71
1870, Apr. 21.....	52.53	36.60	1888, May 1.....	50.48	28.50
1871, Mar. 14.....	49.21	25.89	1888, Dec. 19.....	50.86	26.39
1872, Apr. 12.....	49.49	28.49	1895, Apr. 16.....	52.89	36.55
1873, Apr. 12.....	49.11	28.18	1896, Mar. 3.....	52.99	38.79

REMARKS.—In some cases the height at lower locks was not taken at the same time as the greatest height above the dam, of which the crest is 43.13, but is the greatest height observed for the same day. In 1785 was a great freshet ranging between those of 1852 (53.12) and 1896 (52.99).

The variations in freshet height at lower locks for nearly equal heights above the dam will be noted, indicating the effects of varying local conditions below the dam on freshet heights.

At the Pawtucket dam in Lowell the flood of April, 1852, necessitated the use of a guard gate across the upper lock. At that flood the river was 14 feet 1 inch above the top of the Pawtucket dam, which is the maximum reached at Lowell in any flood so far recorded. Between January, 1852, and January, 1879, there were seven freshets during which the height of water exceeded 10 feet above the top of this dam, according to a paper by Mr. James B. Francis. The dates and heights are stated as follows in that paper:

April 22, 1852, 14 feet 1 inch above top of dam.
 March 20, 1859, 10 feet 8 inches above top of dam.
 April 20, 1862, 10 feet 9½ inches above top of dam.
 March 14, 1865, 10 feet 9 inches above top of dam.
 October 6, 1869, 10 feet 3¾ inches above top of dam.
 April 21, 1870, 13 feet 1¾ inches above top of dam.
 December 12, 1878, 10 feet 11 inches above top of dam.

In a letter dated March 5, 1913, the chief engineer of the Locks & Canals Co. brings the record to date by adding the following:

April 16, 1895, 11 feet 5½ inches above top of dam.
 March 3, 1896, 12 feet 9½ inches above top of dam.
 April 8, 1901, 10 feet 3 inches above top of dam.

5. *Headroom and clear span of bridges.*—The river is crossed by the following bridges, beginning at the mouth, and listing them in the order they would be passed by a vessel proceeding upstream to Ward Hill, 1 mile above Haverhill.

Name of bridge.	Distance above mouth.	Clear height at mean low water.	Range of tide or river stage at bridge.	Clear opening in draw.
	<i>Miles.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>
Highway (Newburyport).....	3	20.8	7.58	{North 76 South 71
Boston & Maine R. R. (Newburyport).....	3	20.8	7.58	{North 69 South 64
Deer Island Bridge:				
North Channel.....	5½	2 15	2 6.86	54.0
South Channel ¹	5½	36.26	2 6.86	³ 220.5
Rocks Bridge.....	12	23.0	5.67	{East 54.4 West 54.0
Groveland.....	16	19.5	4.96	{North 64.1 South 64.4
Haverhill (highway).....	19	23.4	4.58	{North 38.0 South 38.0
Boston & Maine R. R. Bridge at Haverhill.....	19½	41.5	4.52	(⁴)
Highway bridge at Haverhill, known as County Bridge.....	19½	35.2	4.52	(⁵)

¹ Erected in place of old Chain Bridge.

² Approximate.

³ Fixed span.

⁴ No draw. Spans are 135 feet wide.

⁵ No draw. Spans are 140 feet wide.

Above Haverhill the suggested route leaves the river, and the canal would have to cross at grade the Salem and Lawrence branch and the main line of the Boston & Maine Railroad. It would also, near Ward Hill, pass under the main line of the Boston & Maine Railroad, the bridge being about 50 feet above the water in the canal. The number of highway bridges to be crossed at grade by the canal is indeterminate, but there would be several in South Lawrence.

6. *Unusual difficulties of navigation.*—The bar at the mouth presents the first difficulty. The river carries a certain amount of sediment for 10 miles toward the south, and for many miles toward the north the coast consists of sandy beaches forming a cordon littoral in front of low-lying marshes. The beach material is easily moved by waves and currents, and the unimproved Newburyport bar had the characteristics usual in such circumstances—shallow depth (6 feet at mean low water), shifting channel, and heavy breakers except in calm weather, which in this locality is usual only from May to November; for the rest of the year and at irregular intervals sudden storms are frequent. Two jetties have obtained and maintained for some years a depth at mean low water across the bar, varying between 11 and 13 feet; the channel, while somewhat shifting, seems to wander between more narrow limits than formerly. The mean rise of tide on the bar being 7.68 feet, 17 feet is about the limit of safe draft to which vessels bound to Newburyport can be loaded. On the bar, between the jetties and at some other points, flood-tide currents are very strong at the very time when vessels must enter to take full advantage of the greatest depth. Unless inward-bound vessels loaded to such depths reach the bar just before high tide they must anchor off the bar, where there is no shelter, and this makes navigation hazardous except in calm weather. The channel to Newburyport has about 2 feet less actual depth than that over the bar, but as there are no waves the available depth is not widely different. Several ledges lie near this channel, which is neither wide nor entirely straight. Near the city there is a large sand shoal, which is said to be somewhat shifting as to depth and position at times of freshets.

Barges drawing 17 feet are sometimes towed in over the bar by two tugs and brought up to the city by one tug on a single high water. At high tide Newburyport now marks the upper limit of 17 feet draft. Fourteen feet at high tide can be carried up to Amesbury Ferry, but ocean-going barges of so small draft are getting scarce. For other river points all freights, mostly coal, now break bulk at Newburyport, are rehandled once or twice, according to circumstances, and are loaded on special river lighters of from 4 to 8 feet draft and from 35 to 240 tons burden, owned by the Merrimac River Towing Co., which has a fleet of 16 of these lighters and 3 tugboats. The cost per ton is stated to be 10 cents for use of scows and 23 cents for rehandling. (H. Doc. No. 339, 59th Cong., 2d sess., p. 4.) The present towage charge from Newburyport to Haverhill (16 miles by river) is stated to be about 25 cents per ton of coal. In this 16 miles the unusual difficulties of navigation are mainly due to curvature, comparative narrowness of the navigable part of the channel where it passes through areas of broad open water, the difficulty of keeping such reaches properly marked by buoys or beacons, due to floods, swift currents, and drifting ice, and the necessity of having the tug and tow start just before the crest of the flood tide is reached at Newburyport and "carry that tide up the river"; to do this the rate of progress of the vessels must be as nearly as possible the same as that of the crest of the tidal wave in order to keep the greatest available depth of water under them as they ascend the stream. If under these conditions the tow accidentally grounds on rocky or uneven bottom the tide begins to fall almost immediately, and both the strain on the grounded vessel and the delay are a maximum, for the boat will not float again for nearly 13 hours and the tide will fall the full range at that place.

In 1905 the ponding of water in the pools above the dams at Lawrence, Lowell, and Nashua was the subject of complaint under section 10, river and harbor act of March 3, 1899. Investigation showed that while the mills were shut down on Saturday afternoons and Sundays the entire fresh-water flow of the river was stopped at times for over 24 hours. The power company claimed that due to its large reservoirs farther up the river and its careful utilization of all available water more water had actually flowed in the five dry months (June to October, inclusive) than had been the case for 20 years before the act of March 3, 1899, became law. Observations at Haverhill on August 26 and 27, 1905, by a United States inspector indicated that the tide was 15 inches lower on Sunday than on a week day, probably due to ponding. As a final result of the complaint, no legal prosecution of the power company was made, in view of an opinion of the local United States attorney, dated July 7, 1906, to the effect that there was doubt as to the applicability of the statute to dams constructed long before the passage of the act under which complaint was made. By lowering the height of the high water, ponding constitutes a real and unusual difficulty of navigation. If the above opinion of the district attorney be correct, there may be considerable doubt of the right of the United States without compensation to take water for lockage purposes from the pool created by the Lawrence dam. For long periods every cubic foot of water so diverted from the pool would be an absolute loss to the

power companies; this is proved by the following quotation from page 9 of their protest¹ against a bill introduced in 1907 in the Massachusetts general court to require them to construct a safeguard above the Lawrence dam:

Except for a short time after heavy rains, there is generally no water running over the dam. All that comes down the river is drawn into the canals and used in manufacturing. Sometimes for a month or six weeks continuously no water wastes over the dam, days, nights, or Sundays.

Under the heading "Water power" this question will be further discussed. (See also Senate Doc. No. 274, 62d Cong., 2d sess.)

Even at the "top of the tide" the currents in certain bends, and especially in certain draw openings, are extraordinarily swift. On the ebb they are not coincident in direction with the flow on the flood, and therefore fenders can not be so placed as to suit the direction of flow at both tides. Heavy ice renders it necessary to provide fender piers, or "draw rests," as they are locally called, of unusual weight and stability; they are rigid, unyielding structures against which it is unsafe for a barge to swing under the impulse of strong currents. Rocks Bridge is perhaps the worst place on the river on this account. There are also periods in the season of open river when freshets make currents so strong as to lay up river traffic for over a week at a time in the spring and for days at a time later in the open season.

Between Haverhill and Lawrence there is no navigation at all, except for pleasure purposes, and the danger of submerged bowlders, swift currents, and the lack of any objective point which can be reached, except for picnic purposes, have rendered even this use very slight. About a mile and a half above the city, to the foot of Hazeltine Rapids, was as far as a naphtha boat could be hired to go at the time of inspection. For the upper half of that distance rocks and bowlders made great watchfulness necessary to avoid breaking the propeller or grounding outside of the unmarked channel. At the time of summer low water the river from this point to the dam at Lawrence becomes a series of detached ponds whenever the natural flow is stopped by shutting down the mills. (See photographs,¹ Appendix F.)

At low stages the channel in the 7-mile pool formed by the Lawrence Dam has considerable depth and gentle current for the lower 5 miles; for the next 2 miles it is obstructed by large bowlders; from that point to the lower lock in the Pawtucket Canal, in the city of Lowell, a distance of about a mile and a half, there is no practicable channel, the river being a succession of rapids called Hunts Falls, the fall in that distance being about 12 feet. In the lower 5 miles of the Lawrence pool there is considerable pleasure boating, but no freight traffic, so far as could be learned. On four occasions in the last 65 years pleasure parties, containing nine people in all, have drifted over the dam, seven people being drowned. The average interval between the accidents has been about 14 years. In 1907 an effort was made to enact a State law requiring the Essex Co. to construct and maintain a floating timber boom across the river above the dam "between the 1st day of April and the 1st day of November of each year." It failed to become a law, but a boom is

¹ Not printed.

now placed across the river above the dam by private boating interests at certain seasons of the year.

7. In accordance with section 2, subparagraphs (a), (b), and (c) of the river and harbor act approved July 25, 1912, the following data have been secured:

(a) *Terminals*.—Terminals for transferring water-borne freight and passengers to the shore exist at Newburyport, Amesbury Ferry, Amesbury, Merrimacport, Groveland, and Haverhill. At Newburyport the upper wharves without railroad connection are as follows: (1) Above the highway bridge, only abandoned structures; (2) below that bridge and on north bank, one oil wharf with pipes and pumps to unload ocean-going oil barges into tanks; and (3) one wharf for fishing nets, reels, etc.; on the south bank there are (4) a coal pocket and steam equipment for taking coal out of barges and storing it; (5) a similar plant; (6) boat railway; (7) pier of Merrimac River Towing Co., with power equipment for unloading barges and transfer of contents to smaller barges; (8) abandoned wharf; (9) wharf and closed warehouse for package freight, formerly used by a steamer no longer running between Newburyport and Haverhill. Good highways adequate to the local needs serve the above wharves. The lower wharves have railroad connections, and are as follows: (1) Large piers and warehouses of Philadelphia & Reading Coal & Iron Co., with first-class equipment for handling and storing coal; (2) a coal wharf, steam hoist; (3) similar wharf with 2 covered coal pockets; (4) cold-storage plant with facilities for unloading fishing vessels; (5) effective coal plant with three overhead trestles and large storage; (6) a bulkheaded lot occupied by coal piles; (7) lumber wharf and yard; (8) yacht club pier and clubhouse; (9) below this a double-track railroad runs close to the water's edge for about 1,000 feet, but the adjacent water is shoal. There is physical connection between all the lower wharves and the Boston & Maine Railroad, and at the Philadelphia & Reading Coal & Iron Co. wharf there is opportunity to load cars by gravity from pockets overhead, or by steam hoist direct from lighters lying at the wharf. The pockets serve four railroad tracks at once, if desired, each track having a train of several cars loading simultaneously. The other wharves are without such facilities for interchange of water-borne coal to cars, but it is simply a question of making the installation, as the tracks are available.

So far as could be learned there is no contract for interchange of traffic by prorating as to such long-distance traffic as may be desired to be carried partly by rail and partly by water to its destination; in addition to the railroad tracks good highways adequate to present and future needs serve all the lower wharves. There are no wharves in Newburyport which are owned by the public and open to all on equal terms. The private wharves in good repair are almost exclusively used by their owners, in connection with their coal, oil, fish, or towing business, and are in consequence not open to all on equal terms. The dilapidated structures appear to be open to anyone, but not by any specific authority. The water front of the town below the bridges is fully occupied by existing structures; no considerable area of public space is available for public wharves. Above the bridge is a full mile of unutilized water front, and land can be

formed below the town by filling in the flats; the construction of public wharves on some parts of these areas by the State or by the municipality would suffice to insure against monopoly. Before enlarging the present project for improving the river between Newburyport and the ocean, it would appear essential to insure cooperation by municipal or State authorities in connection with this terminal matter. At Amesbury Ferry there are two coal wharves with steam equipment, handling together 4,000 to 5,000 tons of coal per year, from barges drawing not over 15 feet; at Amesbury, a short distance up the Powow River, which here enters the Merrimack from the north, is a coal yard and wharf with steam appliances, handling per year about 15,000 tons of coal from barges of the class running between Newburyport and Haverhill; at Merrimacport, on the north bank of the Merrimack River a short distance above Amesbury Ferry, is a coal wharf with steam equipment handling perhaps 4,000 tons of coal a year from the river barges, and on the south bank, 2 miles below Haverhill, at Groveland, is a coal wharf with steam equipment handling between 2,000 and 3,000 tons of coal per year. All of these are private wharves, without any rail connections, but with good highways for access, and are not open to all water carriers on equal terms, except to the extent necessarily involved in the actual condition that all the barge traffic is now conducted on the river by a single towing company, which supplies the barges themselves as well as the towboats that pull them. At Haverhill there is a very different condition of affairs. There are some 20 quay walls locally known as wharves. They are usually from 300 to 400 feet long and many of them have sufficient depth along their fronts to insure that barges drawing 10 feet shall remain water borne even at low tide. In the public hearing held October 4, 1912, it was stated that some of these wharves are public landings, and have been so occupied since the city first secured a charter. Alderman Hood stated at the hearing:

There are plenty of docking facilities in the city of Haverhill, and I have no doubt that the city of Haverhill would cooperate with the United States Government and with the Commonwealth of Massachusetts in bringing about any terminal facilities or such other things as may be necessary.

The city now controls several sites with 300 feet or more river frontage which could be made into thoroughly effective public landing places, open to all water carriers on equal terms. At the present time the wharves in Haverhill on the north bank of the river have no railroad connections, but spurs could be run to the wharves without physical difficulty, if such connection were regarded as advisable. On the south bank, in what is now Haverhill but is also known as Bradford, the box-board factory wharf has a railroad spur so that it can get coal either by water or by rail. This is true of one other wharf on that bank, though the actual connection is not so complete or convenient for interchange of coal from barges to cars, if such exchange were desirable. I understand that there is, however, no existing contract for interchange of traffic by prorating as to such long-distance traffic as may be desired to be carried partly by rail and partly by water to its destination. Good city streets are closely adjacent to the wharves in Haverhill and are adequate for all present commercial uses. The city authorities seem to be thoroughly aroused to the desirability of avoiding monopoly and to be doing all

in their power to encourage effective water competition in freight matters. At the hearing, and in subsequent correspondence, there is ample evidence of wide popular interest in Haverhill in the matter, and of the willingness of the municipal authorities and commercial bodies to assist in developing the river, even to the extent of financial assistance in paying for the work. Mr. Leslie K. Morse, president of the Merrimack Valley Waterways Association, filed the following statement of property owned by the city of Haverhill in 1912, bordering on the river, which indicates ample opportunity for the erection of public landing places open to all water carriers on equal terms.

Haverhill city property bordering on Merrimack River.

1912.

Lot, etc., No.	Description.	Area.	Bordering river.	Value.
		<i>Sq. ft.</i>	<i>Fect.</i>	
37-90-1.....	Land.....	12,550	245	\$375
19-86-3.....	do.....	15,500	215	4,500
20-86-2.....	do.....	4,207	32	800
21-90-5.....	do.....	9,480	85	1,150
12-49-1.....	do.....	5,600	80	5,600
12-49-2.....	do.....	54,360	165	163,075
12-49-1.....	do.....	5,600	80	5,600
52-227-4.....	do.....	22,900	105	300
55-248-7.....	do.....	60,600	470	1,825
154-G417-1.....	do.....	66,500	900	150
118-630-2.....	do.....	37,150	300	1,850
145-728-2.....	do.....	108,000	500	400
151-788-21.....	}	566,280	900	900
151-788-22.....				
1-1.....	Way.....		45	.....
5-22.....	do.....		33	.....
5-22.....	do.....		20	.....
6-27.....	do.....		25	.....
12-50.....	do.....		25	.....
58.....	do.....		50	.....

Above Haverhill there are no existing terminals, but the question of provision of public wharves and terminal facilities was taken up at the hearing in Lawrence, and by the Merrimack Valley Waterway Board, a State commission appointed under the provisions of chapter 708 of the Massachusetts Acts of 1912, which has extended to me willing and effective assistance in securing data for this report. On page 21 of the United States hearing of October 4, 1912, the mayor of Lawrence, Hon. Michael A. Scanlon, states:

The State of Massachusetts, I think, is prepared next year to pass a bill appropriating a million dollars. The cities along the Merrimack Valley are prepared to raise another million to go into this with, and we feel that in view of the fact that we are willing to help ourselves in this matter the least the United States Government can do would be to help along with as much, at least, as we are willing to give here.

No definite statements were made as to public wharves at Lowell, except by a Mr. Pierce, who said:

From Hunts Falls, from the commencement up above the mouth of the Concord River, the Locks & Canals Co. has been constructing for many years, and has it now nearly constructed, a long granite embankment. * * *

Entering the Concord River at a distance of about 500 feet is the commencement of a fine set of locks and canals, and which by three rises puts one above Pawtucket Dam. There is a perfect chance for all kinds of wharfage along this new embankment which is now built by the Locks & Canals Co. on either side. The city of Lowell has a large public city landing above the mills.

Definite promises were made at the hearing by Mr. James McMan-ninen, of Dracut, and Mr. John H. Murphy, representing the Lowell Board of Trade, to give direct answers in writing to the questions contained in the circular distributed at the hearing (Appendix A¹ to this report). To date neither has submitted an answer. In that circular it will be seen that much stress was laid on definite data as to terminal questions and cooperation by the interested parties. In reply to the circular letter of the Merrimack Valley Waterway Board definite replies as to public wharves were received as follows:

Salisbury: Would not probably care to go to the expense of building a public wharf.

Amesbury: We feel as if we had no jurisdiction in regards to this matter, but would be willing to have an article inserted in the Town Warrant of March next to see what action the town would take in the above matter.

Merrimac: The town is now having its landings defined by the county commissioners. We have three, two of which we have already had located and surveyed. So that we are able to offer for public use two good landing places on the Merrimack River in Merrimac.

Groveland: That undoubtedly the town will do all that is possible to help the good work that you have commenced.

Haverhill: The city of Haverhill will be only too willing to furnish the necessary landing places for public use in the city of Haverhill and upon the Merrimack River at such time as the public necessities shall require. The city of Haverhill has at the present time some 8 or 10 public landing places, and several of these could readily be equipped with wharfage facilities. I can assure you that our council will do all necessary things to cooperate with your honorable board.

Methuen: The matter would have to be brought before the voters at a town meeting.

Lawrence: That the city council of Lawrence, the legally elected and qualified municipal governing board of the city of Lawrence, believing that the dredging of the Merrimack River so that it will be navigable would be of inestimable benefit to Lawrence and its suburbs, do hereby favor the construction of a municipal wharf or pier to accommodate any vessels which would come up the river from the sea in the event of the said river being made navigable, and do further pledge (so far as they are able) the city of Lawrence to the erection of said wharf or pier in the event of the said river being made navigable for coastwise vessels.

Lowell: On behalf of his honor the mayor and members of the municipal council, I beg to acknowledge receipt of your communication of January 17 and to say that the same will be fully considered at a meeting of the council to be held on Tuesday, January 28, at 2 o'clock p. m. You will be promptly advised of the council's action, which I believe will be favorable.

(b) *Water power, cooperation, etc.*—The river and harbor act approved July 25, 1912, requires this report—

to contain such data as it may be practicable to secure in regard to * * * the development and utilization of water power for industrial and commercial purposes * * * : *Provided*, That * * * consideration shall be given only to their bearing upon the improvement of navigation, to the possibility and desirability of their being coordinated in a logical and proper manner with improvements for navigation to lessen the cost of such improvements and to compensate the Government for expenditures made in the interest of navigation, and to their relation to the development and regulation of commerce.

The original intent of this legislation was probably to cover the creation of new water powers as part of work in aid of navigation, but its wording is such as to justify a very careful study of the question of utilizing, so far as may be economical and legal, the existing Merrimack River water-power developments. The dams and locks on the Merrimack River were originally authorized under a charter

of the State of Massachusetts (vol. 1, ch. 382, Special Laws of Massachusetts) which was passed January 27, 1792, the preamble reading:

Whereas removing the obstructions to the passing of boats, rafts, and masts upon Merrimack River from the divisional line of New Hampshire and Massachusetts to the tidewaters of the said river will be of great public utility * * *

Subsequent acts permit purchase of mills and control of water powers (January 27, 1825); require the maintenance of free landings (act of April 7, 1835); acknowledge a quasi proprietary right in the Locks & Canals Co. to the water in the river by a provision that the water taken by the city of Lowell shall not be sold for power purposes, except to generate steam (ch. 435, Acts, 1855); remove the requirement to maintain and keep up free landings (ch. 106, 1889, and 238, of 1900); and, as late as May, 1905 (ch. 385), prohibit the Boston & Maine Railroad and others "in any manner obstructing the free flow of water through said canal or the free passage of boats and rafts therein."

The State has thus for over 121 years defined and prescribed limitations as to the purpose and use of the flowing water in the Merrimack River, guarding on the one hand the rights of navigation and on the other the rights to the power produced by the dams now owned by the Essex Co. In this connection the opinion of Mr. Taft, Secretary of War, given on February 23, 1907, in connection with the Des Plaines River, is of interest:

If the State has any control over the water power which it may exercise in conflict with the claimed rights of the riparian owner, then it must exercise it itself through its own legislation and through its own executive officers. All the United States does, assuming it to be a navigable stream, is merely to protect the navigation of the stream. With reference to the water power, it has no function except in respect to water power which it itself creates by its own investment in property that it itself owns, and then, of course, it may say how that water power shall be used.

But with respect to the water power on a navigable stream, which may be exercised without interference with the use of the river for navigation purposes, that is controlled by the laws of the State. It is controlled by the riparian ownership and by the common law as it governs those rights.

(See also report of subcommittee on dams and water power to Committee on Interstate and Foreign Commerce, House of Representatives, 60th Cong., 2d sess., February 25, 1909.)

If the United States had built the dam under its power to regulate navigation there is little question of its right to charge for the power artificially developed by its structure. As stated in congressional debates, it could have appointed an agent and have made any agreements with such agent for his compensation and for repaying to the United States the money put into the work, which, in making navigation possible, also created valuable power. Such an agreement was in fact made by the Commonwealth of Massachusetts with its agent the Locks & Canals Co., when, by special law of January 27, 1825, it allowed that company to acquire mills, real estate, and to conduct manufacturing operations, enabling the company to derive revenue from water passing its dams in excess of the needs of navigation, this being virtually a payment by the Commonwealth, in view of the money expended by the agent of the Commonwealth in originally building the dams for navigation. The Commonwealth derived its benefits in the shape of navigation at reasonable toll rates established by its own statutes. The Locks & Canals Co. derived income

from the tolls, upon which alone it originally depended for its income, and later from the sale of water power. In order to pass the Lawrence Dam the United States must construct a canal connecting with the pool above that dam; by such connection it will derive much benefit from the artificially created depth above the dam, thereby gaining an unknown but great reduction in the cost of creating a deep channel to Lowell. To operate its canal it must use water for lockage, the lockage water being drawn from a level higher than the natural level of the river surface at Lawrence, by an amount at least equal to the height of the dam. By a high-level canal carrying the upper pool level down the south side of the river to a point below Mitchells Falls and there locking down into the tidal river the United States can save the cost of much rock excavation in the bed of the river, which would be unavoidable if the Lawrence Dam were nonexistent.

Before recommending such utilization of the high-level pool it has seemed necessary to study and quote such opinions and decisions bearing directly on the relative rights and powers of the United States and the several States as were accessible to the district officer making this report. Up to this time the claim of the United States to water in a river has been held to be paramount where such water is used solely for navigation purposes, a possible exception being water needed for sanitary uses (see the case of the Chicago Drainage Canal). Does this paramount right cover the utilizing at this late day of the increased level of the water in the pool created by the present Lawrence Dam, which was legally constructed about 1848 by the State of Massachusetts through a legally appointed agent, long prior to any act of Congress asserting the superior right of the United States? The State created the pool originally for navigation only but later, for valuable considerations, permitted all water in the pool not needed by the State for its navigation to be used for power development by private parties. Would the withdrawal for navigation purposes of water from the pool by the United States constitute a "taking" for public use, for which payment should be made? Could such a claim be made either by the State or by its agent, the power company?

In the State of Ohio a decision of the State Supreme Court, based on the common law similar to that in force in Massachusetts, reads:

Hence the State in its exercise of the right of eminent domain can subject the waters of such stream to other public uses, the same as any other private property, by making a just compensation for the injury and not otherwise.

Citing this decision in the debate on the Connecticut dam bill (p. 3171, Congressional Record, 1913), it was stated:

That means the State can authorize that right to be secured by condemnation proceedings in behalf of a superior public purpose. For instance, to illustrate: Water power is created, in the first instance, to operate a gristmill or a saw-mill, and eventually a big town or city grows up in the neighborhood. The town or the city may need the water in that dam for domestic use to supply its inhabitants. That, under the circumstances, would be a superior public right, and the State could authorize the property of the water-power company to be condemned for that purpose, but it could not take it absolutely without compensation.

The closely related subject, Can the United States charge power companies for the privilege of building dams and creating power in navigable streams? has been at issue between Congress and the

Executive for over four years, and many of the arguments apply to the present question. The veto of several dam bills and, on May 23, 1908, the passage of the Rainy River dam act over such a veto have a direct bearing. In a committee report dated February 25, 1909, the Committee on Interstate and Foreign Commerce, House of Representatives, discussing the subject of a general dam law, say:

These immense natural resources * * * should be developed for the real welfare of the whole country and not solely for the benefit of those few individuals who had the shrewdness and foresight to acquire such property rights as may be sufficient to dominate and utilize mostly for themselves these privileges. At the same time due regard must be had to the private rights which such individuals may have acquired and of which they can not be deprived without due process of law and which can not be taken from them without just compensation.

This report is noteworthy because it expresses the views of an important House committee after it had been considering nearly 10 months the veto message of April 13, 1908, in which the President said:

The present policy in making these grants is unwise in giving away the property of the people in the flowing waters to individuals or organizations, etc.

The Congressional Record for February and March, 1913, contains valuable data on the subject, in connection with the Connecticut River dam bill (S. 8033), which passed the Senate February 17, 1913 (74 yeas, 12 nays, 9 not voting); it contained a clause requiring an annual charge to be paid to the United States by the power company. A charge by the United States against the owners of the same Connecticut dam was an item in the river and harbor bill (H. R. 28180) when it passed the Senate. A similar charge was a feature in another item regarding power derived from a dam built by the United States in the Mississippi River near St. Paul, Minn. Both items went out in conference, on account of pronounced objection on the part of the House of Representatives to making such a charge; all this accentuates the likelihood of congressional opposition to an item in a river and harbor bill involving a possibility that the United States might have to pay a power company for the use of the high-level pools constituting already improved reaches of the Merrimack River, although in the first instance these pools were, in good faith, created solely for navigation purposes. That grave doubt still exists as to the relations between the Federal and State Governments in connection with the control of water powers is emphasized by the following remarks of Senator Brandegee on the Connecticut River dam bill (p. 2748, Congressional Record for February, 1913):

Perhaps half the lawyers in the Senate think one way and the other half the other on this question; perhaps the court itself may divide; but we certainly can never arrive anywhere in the development of our water power, which is now running to waste all over the country, by having the Chief Executive veto all the bills that we pass which do not contain a provision for some sort of compensation and by having one House or the other block their passage if they do contain it.

Massachusetts is not one of the States in which it has been established as a rule of property, governing riparian land, that mere priority of occupation or appropriation gives rights superior to those of the riparian owner in the beneficial use of the waters and the beds of streams. The water-power developments at Lawrence appear to

be owned subject to the common law (slightly modified), just as was the case with the Connecticut River dam.

In the report of the Board of Engineers on the 14-foot waterway from Chicago to St. Louis (H. Doc. No. 263, 59th Cong. 1st sess., p. 11), it is stated:

It is the opinion of the board that the sanitary reasons for the abstraction of water so far exceed and overshadow the commercial reasons that the amount should be strictly limited by the sanitary necessities of the case.

This has a bearing on the question of the abstraction by the Metropolitan Water and Sewerage Board of drinking water from the tributaries of the Merrimack River, of which complaint was made at the hearing in Lawrence, as being a cause of extreme low water in the river. At the Lawrence hearing and in the circular distributed thereat an attempt was made to learn whether any charge would be attempted by the Essex Co. for such water as might be required by the United States for lockage past the Lawrence Dam, but absolutely no reply was obtained. It has since been impossible to get an expression of opinion on this subject from anyone in authority. Whether the Metropolitan board pays the Essex Co. for the water they now prevent from entering the Concord River is not known. The Nashua and Concord Rivers lie wholly in the State of Massachusetts, and their waters apparently come under the reasoning of Mr. Justice Brewer in the case of *United States v. Rio Grande* (174 U. S., 709), where he says, regarding the Croton River:

Its waters are taken by the State of New York for domestic uses in the city of New York. Unquestionably the State of New York has a right to appropriate its waters and the United States may not question such appropriation, unless thereby the navigation of the Hudson be disturbed.

Before the United States appropriates money for a project involving the use of the pool above the Lawrence Dam for navigation, and of water from that pool for lockages in a canal below the dam, this right to use without compensation should be definitely settled.

If the improvement were stopped below the dam at Lawrence, and navigation to that point was provided for by excavation and not by a dam on the river below as proposed in House Document No. 9, Sixty-second Congress, first session, the water surface below the Lawrence Dam would be dropped about 10 feet, the fall at the time of low water being thus increased from about 27 feet to about 37 feet, and the power available in like ratio. In view of this increase in available power, an effort was made to learn whether the Essex Co. would contribute funds to assist in the creation of such an excavated channel. No formal reply was made, but it was intimated that it would cost so much to lower their wheel pits that no financial benefit would result to the mills, and therefore no cooperation could be looked for from that source. It has been held generally that backing up water so as to lessen the available fall at a power dam by the construction of a new dam lower down the river is a taking of power for which payment is due the owner of the original power dam; that this applied in equity to the United States was recognized in the project of Col. Edward Burr for a 14-foot channel to Haverhill to be produced by a dam at Lions Mouth, and for that reason the crest of his dam was kept down to 11.14 feet above mean low water at Black Rocks beacon. On the ground that a 14-foot channel was

too shallow for coastwise barges of the present type, and deeper than would be needed for purely river navigation in suitably designed river barges, since locally recognized as true by all parties, that project was not approved by the War Department or taken up by Congress. To give a deeper channel than 14 feet to Haverhill without producing backwater at the Lawrence tailraces would involve at least 3 feet of excavation. With the crest of a dam at Lions Mouth at reference 11.14 all authorities agree that small discharge at low stages and drowning out at high water would render unmarketable and useless any power developed by that dam. As a summary of the water-power situation it appears that the United States might have to pay high for anything adversely affecting existing water-power installations, and that at this time no assistance, financial or otherwise, can be expected by the United States from power developed or to be developed in connection with the improvement of navigation.

(c) The only other subjects connected with the project so directly as to come within the province of the act are sewage, ice, and the general scope of improvement. A State report on the sewage situation is appended, marked "Appendix G." Sewage and ice both came up at the hearing. A protest against putting in a dam at Lions Mouth was made under date of August 29, 1912, by a Mr. Richard Newell, of West Newbury, on the ground that it would destroy the current in the river and result in a stagnant pool so impregnated with organic matter by the sewers of Lawrence and Lowell as to constitute a threat to the health of the community. In speaking to this question Mr. M. J. Sullivan, president of the Merchants' Association of Lawrence and a member of the Lawrence Board of Trade, said:

It is the general opinion here that the sewers would have to be removed and the sewerage filtered in a very short time anyway, and thence transported to the sea by a large outlet or discharge pipe. That will have to be done soon anyway, and it may well be done at this time.

Mr. Sullivan was asked to answer in writing the other questions in the circular distributed at the hearing. He said he would. No such answers have been received to date. Mr. Ralph D. Hood, alderman, of Haverhill, stated:

The sewerage proposition in Haverhill is to be cared for in the near future. The State board of health are at the present time going over this entire proposition with a view to eliminating the sewage from the Merrimack Valley. That applies to Lowell, Lawrence, Haverhill, Newburyport, and also all our intervening towns.

Mr. Hood also stated regarding ice:

In regard to the effect of existing dams on floods and ice gorges at the time of the spring break-up, I think they help that matter. At Haverhill all ice that comes across the dam is broken up in small pieces. Therefore it does not gather on our bridges, and we have not had an ice gorge for several years. I think the dam helps break the ice up more than anything else.

In regard to the time when it opens up, it is at any time from the 1st of February to the 1st of April, entirely depending upon the season.

As to the general scope of the improvement desired at this time, the matter was well summed up by Mr. Hood, who said:

The trouble is—I did not intend to criticize my betters in any way—that they have simply been down to Congress and got an appropriation of \$10,000 or \$15,000 or \$20,000, a mere drop in the bucket, and come up here and spent it, getting somebody pleased and patting them on the shoulder, and that is the

way it has gone. When any further money is appropriated for this river it should be enough to bring this river up to a certain standard, to be decided upon by your board of engineers and by those who are interested. And then the Commonwealth of Massachusetts, which will take an interest in this matter, will do their part in regard to the furnishing of terminal facilities and will do as much as the United States Government will have to do to develop their portion of the river. By all parties taking hold in this way, with the municipalities along the line, I believe we can all get together and work for a common end and make this river worth something to Essex County, to northeastern Massachusetts, and to the Federal Government as well. And it is only by a concentrated working out on this plan that anything can be done.

8. *References to examination or survey reports and maps or plans not in project documents—*

Section covered.	Congressional documents.				Annual reports of Chief of Engineers.	
	House or Senate	No.	Congress.	Session.	Year.	Page.
Near mouth of river, and thence to above Haverhill: ¹						
1869.....	House...	² Ex. 25	Forty-first..	Second..	² 1869	421
1872.....					² 1873	1, 112
1874.....					² 1876	165
1896.....					² 1896	590
Newburyport to Haverhill, 1897 ³	House...	² 52	Fifty-fifth...	First....	² 1897	865
Newburyport bar to Haverhill, 1894-95.....	...do....	⁴ 168	Fifty-fourth.	...do....	² 1896	616
Hazeltine Rapids to Lawrence, 1871.....					² 1872	961
Lawrence, Mass., to Manchester, N. H., 1881.....					² 1882	532
Lowell to old New Hampshire State line, 1897.	House...	⁴ 242	Fifty-fifth...	Second..	² 1898	884
Newburyport to Haverhill, 9-foot channel, 1903.	...do....	² 311	Fifty-eighth.	...do....	² 1904	872
Newburyport to Haverhill, 12-foot channel, 1906.	...do....	² 339	Fifty-ninth..	...do....		
Removing obstructions at mouth, 1906.....	...do....	⁴ 339	...do.....	...do....		
Mouth of river to Haverhill, 14-foot channel, 1908.	...do....	⁴ 2	Sixty-first...	First....		
Haverhill to Lowell, 1910.....	...do....	² 9	Sixty-second	...do....		

¹ Project of 1870 as extended 1874 and 1896.

² No maps.

³ Existing project, Mar. 3, 1899.

⁴ Contains maps.

9. *Worthy or not worthy.*—This crucial question includes many factors which can be approximated only within wide and uncertain limits without expenditures for surveys. The following data bearing on the subject have been carefully collected and compiled by the State Merrimack Valley Waterway Board, created by chapter 708, acts of 1912, Commonwealth of Massachusetts, and furnished to this office :

ASSESSED VALUATION, POPULATION, ETC.

Bordering upon the river banks are the following cities and towns, with an aggregate population of over 306,000 people: Amesbury, Andover, Chelmsford, Dracut, Groveland, Haverhill, Lawrence, Lowell, Merrimac, Methuen, Newbury, Newburyport, North Andover, Salisbury, Tewksbury, Tyngsborough, and West Newbury.

In these cities and towns, with an assessed valuation April 1, 1912, of over \$250,000,000, are located over 839 mercantile establishments with a capital invested of over \$168,000,000. The value of the stock and raw material used by these concerns annually exceeds \$112,000,000, while the manufactured product is valued in excess of \$187,000,000.

The coal consumption of the above cities and towns exceeds 1,200,000 tons, only approximately 135,000 of which is received by water. It is the opinion of manufacturers along the Merrimack River that if a water route were provided for the receipt of this commodity alone the saving in freight rates would

average from 50 cents to \$1 a ton, to say nothing of the vast saving on general merchandise and raw material received and manufactured product shipped to and from the various cities and towns along the river.

The cities of Nashua, Manchester, and Concord are also situated on the Merrimack River, and in these cities are situated some of the greatest manufacturing concerns in the world, as, for example, the Amoskeag Manufacturing Co. (the largest cotton mill in the world) and the American Locomotive Co.

Freight traffic at Lawrence.

[From figures compiled by the Lawrence Board of Trade.]

	Per annum.
Pacific mills:	
Cotton-----tons--	¹ 5, 000
Wool-----do-----	¹ 5, 000
Coal-----do-----	¹ 75, 000
Miscellaneous freight-----do-----	¹ 30, 000
Woven cloth-----do-----	² 5, 000
Atlantic mills:	
Material-----do-----	¹ 3, 750
Coal-----do-----	¹ 7, 000
Oil and kerosene-----do-----	¹ 200
Manufactured product-----bales--	² 18, 000
Waste-----do-----	² 2, 000
E. Frank Lewis, wool scourer:	
Coal-----tons--	4, 000
Wool handled-----do-----	11, 000
Ayer mill:	
Coal-----do-----	25, 000
Wool-----do-----	8, 500
Pemberton mills:	
Coal-----do-----	2, 200
Cotton-----do-----	1, 350
Miscellaneous freight-----do-----	150
Washington mills:	
Coal-----do-----	67, 000
Wool-----do-----	15, 000
Oil, kerosene, etc-----do-----	15
Waste-----do-----	1, 000

Walworth Bros. use 30 tons of coal per week.

Farwell Bleachery, 8,000 tons of coal per year.

Kimball Shoe Co., 400 tons per year.

SUMMARY OF THE CLASSES OF FREIGHT AND GENERAL STATISTICS AS TO CITY OF LAWRENCE, FROM FIGURES COMPILED BY THE LAWRENCE BOARD OF TRADE.

The Board of Trade of Lawrence have submitted the following figures for the information of the Merrimack Valley Waterway Board, the results compiled from letters sent in by the various concerns in the city of Lawrence with such other figures as were in the possession of the board of trade.

The inward freight itemized as follows:

	Tons.
Soft coal-----	425, 000
Hard coal-----	85, 000
Lumber-----	120, 000
Groceries and provisions-----	17, 000
Merchandise-----	400, 000
Raw material and miscellaneous freight-----	315, 000
Total-----	1, 362, 000

Statistics as to outward freight are very meager, those available to the board of trade amounting to but 45,000 tons.

Official figures obtained from the Boston & Maine Railroad, giving the outward and inward traffic in the city of Lawrence, are as follows: Inward and outward freight, 2,400,000 tons per year.

¹ Incoming freight.

² Outgoing freight.

The freight receipts of the Boston & Maine Railroad for the year 1911 for the city of Lawrence amounted to the sum of \$2,000,000, which is 5 per cent of the gross business of the Boston & Maine system.

LAWRENCE.

Lawrence is the fastest growing city in Essex County. A great manufacturing center, on the Merrimack River, which turns more spindles than any other stream in the world; 26 miles from Boston; 20 miles from the sea.

Population, 85,892; polls, 21,737; assessed valuation, \$75,500,000; tax rate, \$17.60.

The focus of 6 lines of railroads; 30 passenger trains to and from the city daily. Center of a great electric railway plant, controlling 50 miles of track; 9,000,000 passengers a year.

Gas and electricity; low rates for lighting and power. The great dam develops 155 mill powers, 11,896 gross horsepower. Capital of factories using water power, \$15,000,000.

Thirty school buildings; 15,000 pupils in public and private schools. Public industrial school.

Two national, 3 trust companies, 3 savings, and cooperative banks. Assets of savings banks, \$17,000,000.

A handsome public library of 60,000 volumes.

Ninety-five miles of broad, well-kept streets; 3 steam rollers, and crusher plant.

Sixty miles of sewer. Park system of 136 acres.

A water supply—high and low service—unequaled in the world.

An efficient fire department, 9 fire stations; lowest fire insurance rates in the State.

Forty churches. One Artillery, 2 Infantry companies, in handsome State armory.

A shire town of Essex County; courthouse and registry of deeds.

Statistics of the city of Manchester, N. H., prepared under the direction of the Chamber of Commerce of Manchester—This table is included, as the creation of a large coal terminal at Lawrence or Lowell might affect coal prices due to less length of railroad haul and possibility of electric railway coal freighting.

Population:

1910-----	70,063
1900-----	56,987
1911 (county)-----	126,072

Total tax valuation:

1909-----	\$38,102,944
1911-----	\$41,736,846
1912 (full)-----	\$68,452,145

Tax rate per \$100:

1911-----	\$2.04
1912-----	\$1.50

Miles from Boston-----	53
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Trains to and from Boston daily-----	20
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Tributary towns:

Bedford (population, 1,110)-----miles--	6
Goffstown (population, 2,579)-----do--	8½
Hooksett (population, 1,528)-----do--	7
Auburn (population, 637)-----do--	1¼
Goffs Falls-----do--	1½

Has a tributary population of-----	250,000
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Area of city-----square miles--	33.9
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Scholars in—

Public schools-----	5,337
Parochial schools-----	3,395

Miles of—

Water pipe laid-----	117
Streets-----	206

Miles of—Continued.

Sewers	84
Street railway	40
Public parks (area, 160 acres)	13
Churches	42
Volumes in public library	65, 000
Passenger trains north and south daily	60
Cotton and woolen mills	36
Number of people employed	15, 000
Number of spindles	670, 000
Number of looms	24, 000
Pounds cotton used yearly	63, 100, 000
Pounds wool used yearly	15, 300, 000
Yards cotton cloth woven yearly	235, 873, 750
Yards woolen cloth woven yearly	21, 000, 000
Number turbine wheels	50
Annual pay roll, mill operatives	\$6, 200, 000
Savings banks deposits	\$27, 039, 313
Electric light company	1
Electric street lights running all night	625
Bonded indebtedness of city	\$1, 645, 000
Bonded indebtedness of city, exclusive of water bonds	\$945, 000
Sinking fund for city and water bonds	\$716, 885
Number of shoe factories	10
Average yearly pay roll	\$3, 450, 000
Average number pairs of shoes yearly	14, 150, 000
Number operatives	8, 000
Cigar industry employs over	people 850
Pay roll (annual) over	\$6, 000, 000
Number cigars made annually	13, 000, 000
Net annual income on which city is run	\$1, 000, 000
Number of men on police force	53
Appropriation (1912)	\$85, 980
Number of men on fire department	181
Appropriation (1912)	\$138, 575
Population of State (1910)	430, 572

City is on six lines of railroad. Is 41 miles from seacoast. Recreation resorts: Pine Island Park, Massabesic Lake, Uncanoonuc Mountain.

Statistics of Lowell, Lawrence, Haverhill, and Newburyport, Mass., from tables of the Massachusetts Bureau of Statistics for 1910.

Town.	Number of establishments.	Capital invested.	Value of stock used.	Amount wages yearly.	People employed.	Value of product.
Lowell	234	\$53, 048, 164	\$34, 329, 970	\$13, 453, 078	31, 449	\$56, 612, 154
Lawrence	129	79, 657, 571	41, 739, 427	12, 178, 666	27, 983	69, 574, 701
Haverhill	325	14, 498, 562	22, 188, 928	7, 175, 882	12, 186	35, 650, 830
Newburyport	53	4, 876, 477	3, 951, 983	1, 581, 543	3, 156	7, 002, 724

Statistics of Nashua and Manchester, N. H., for 1908, compiled under Gov. Floyd and board.

Town.	Number of establishments.	Capital invested.	Value of stock used.	Amount wages yearly.	People employed.	Value of product.
Nashua	92	\$7, 321, 960	(¹)	\$3, 452, 026	7, 451	\$17, 176, 439
Manchester	157	25, 208, 766	(¹)	9, 744, 839	23, 699	40, 397, 334

¹ No data given.

SUMMARY OF ANSWERS TO QUESTIONS OFFICIALLY ASKED BY THE MERRIMACK VALLEY WATERWAY BOARD.

QUESTION NO. 1.

What amount of coal per year brought by rail is now used by you, and what is the approximate freight charge to you per ton—or what is the cost per ton of coal delivered to you?

ANSWER.

	Tons coal delivered.	Price per ton.	Freight rate.
Lowell.....	184,425	\$4.30-\$8.50	\$3.25 all-rail from mines to Lowell.
Lawrence.....	404,495	4.50- 8.00	\$2.25-\$2.35 all-rail from mines to Lawrence.
Haverhill.....	61,485	(¹)	\$2.95 all-rail from mines to Haverhill; 85 cents all-rail from tidewater (Newburyport, Salem, or Mystic).
Amesbury.....	6,930	8.60- 9.20	\$3.05 all-rail from mines to Amesbury.
Newburyport.....	137,450	4.36- 8.00	\$3.05 all-rail from mines to Newburyport.

¹ Varying.

QUESTION NO. 2.

What, in your opinion, would be the saving in cost to you, per ton, if the coal which you require could be brought by water instead of by rail?

ANSWER.

Lowell: The saving per ton was expressed as from 35 cents to \$1, which could be saved were the coal received by water rather than by rail.

Lawrence: It is the opinion of the various firms in the city that from 35 cents to 50 cents could be saved a ton were the coal to be received by water instead of by rail.

Haverhill: The opinion was expressed that from 50 cents to \$1 per ton would be saved could the coal be brought by water.

Amesbury: No information obtainable.

Newburyport: A saving of from 10 to 15 cents was reported. The Philadelphia & Reading Coal & Iron Co., owners and occupants of the largest wharf in the city, are of the opinion that the saving to them would be of large proportions if the river were deepened, since the company has several classes of barges which are now unable to enter Newburyport Harbor because of the shallow depth of water. Were the river deepened vessels with a larger coal capacity could dock at the wharf, and in one cargo the company would receive the same amount of coal as is now received in two of the vessels touching at this port, by reason of the increased capacity of the barges.

QUESTION NO. 3.

What amount of freight, other than coal, is now brought to you by rail per year?

ANSWER.

Lowell: This question was answered by many merchants, and resulted in a total of 58,365 tons of freight being received by such concerns annually. This total must not be taken as an accurate statement of the tonnage of inward freight (other than coal) in the city of Lowell, for the reason that a great many firms in answering the question expressed the value of the freight (exclusive of coal) instead of expressing the tonnage. For instance, one firm pays annually \$94,000 in freight charges, another firm pays \$24,000, and then other concerns report that their freight bills for 1911 were \$119,500. Other firms indicated specific property, such as 7,000,000 feet of lumber, etc., which is received by them annually.

Lawrence: Replies to this question received by the Merrimack Valley Waterway Board totaled 271,635 tons of freight.

Haverhill: This question resulted in a total of 73,700 tons of freight other than coal now received in Haverhill. Many firms answering this question gave the money value of the freight instead of the customary units of weight; as, for example, one firm paid the sum of \$2,500 in freight charges last year.

Amesbury: That upward of 2,000 tons of freight were received in the town.

Newburyport: A total of 9,800 tons. The Standard Oil Co., the owners of a wharf and a plant on Rings Island (which island is situated directly across the river from the city of Newburyport), reported that they receive by water 597,309 gallons of gasoline and oil, or a total of 1,792 short tons.

QUESTION NO. 4.

What, in your opinion, would be the saving to you in freight charges if the same kind of freight could be brought by water instead of by rail?

ANSWER.

Lowell: It appeared to be the general opinion as expressed by the answers received that the saving to the business concerns in the city of Lowell would be from 25 to 50 per cent if freight could be brought by water to the city.

Lawrence: The opinion is expressed that from 40 cents to \$1 per ton would be saved on freight were a water route available. Many firms answering this question gave a lump sum as the estimated saving; as, for example, "We would save \$1,500 on freight charges," etc.

Haverhill: The opinion expressed is that from 33 $\frac{1}{3}$ to 60 per cent could be saved. Many firms, in answering this question, instead of giving their answers on a percentage basis figured the rail rates and water rates and gave the answer in dollars and cents.

Amesbury: No information obtainable.

Newburyport: The opinion expressed was that the saving would be from 33 $\frac{1}{3}$ to 50 per cent. Capt. George F. Woodman states that there are 300,000 tons of general freight in and out of Newburyport annually; that the saving to the people of Newburyport in transportation charges would amount to 50 per cent.

QUESTION NO. 5.

What amount of freight is now shipped by you by rail which could be shipped by water if the Merrimack River is improved to the extent of providing an adequate channel from the mouth of the river to Lowell?

ANSWER.

Lowell: The answers to this question resulted in a total of 11,320 tons. The majority of replies were very general, and the amount of tonnage was not expressed. The firms answering, while not giving the amount of tonnage of their freight, replied with such answers as, "Would ship all of it," "Could ship some of it," and others gave specific commodities which they might ship by water if a water route was provided.

Lawrence: The answers brought out a total of 35,848 tons of freight which might be shipped by water were the river improved so as to make shipping possible. The tonnage to this question will not do justice to the amount of freight which might be shipped by water because a great many of the business houses in reply to this question answered in a general way instead of answering in the customary units of tons; for example, "We would ship all of our freight by water," "As much of our raw material comes from the South we would make use of a water route," "One-half of our outward freight of a similar nature." Thus no light is thrown on the question of what the actual tonnage would be.

Haverhill: Answers to this question totaled 33,000 tons, but this result is no indication of the amount of freight which could be shipped by water, as many of the firms in answering this question replied as follows: "All of it" (meaning their freight), while others named specific things that they might ship by way of a water route, for example, "9,000,000 feet of lumber," "500,000 box shooks," "12,000 cases of shoes," etc.

Amesbury: No information obtainable.

Newburyport: No answer.

QUESTION NO. 6.

Do you own, lease, or occupy or control a wharf or landing place on the Merrimack River adapted to use for the receipt and dispatch of freight and passengers?

ANSWER.

Lowell: In answer to questions 6 and 7, it appears that no business house has the ownership or control of any wharf in the city. Many firms replied that there were enough city landings which, if improved and developed, would provide ample facilities for the proper receipt and dispatch of passengers and freight, were the river improved; and that they (the firms answering) would undoubtedly use these wharves in conjunction with others.

Lawrence: Only two firms had the ownership or title to land on the waterfront, but the majority are in favor of procuring a wharf to be used in conjunction with other firms for the receipt and dispatch of freight and passengers.

Haverhill: Many of the firms in Haverhill own and occupy wharves, and all are willing to provide a suitable wharf were the river improved to such an extent as to make it navigable for vessels of fair draft.

Amesbury: At least three firms own and occupy wharves.

Newburyport: This question disclosed the fact that there were six firms who now own and occupy wharves in Newburyport.

QUESTION NO. 7.

If a project for the improvement of navigation in the Merrimack River from the mouth of the river to Lowell should be carried out providing an adequate channel, would you provide a suitable wharf or landing place on the river for the receipt and dispatch of either freight or passengers, or both?

ANSWER.

Lowell, Lawrence, Haverhill, and Amesbury: Answered under question 6.

Newburyport: Answered in the affirmative in almost all cases.

QUESTION NO. 8.

What, in your opinion, should be the least depth in any improved channel of the Merrimack River between the mouth of the river and Lowell?

ANSWER.

Lowell: Opinion placed the depth at from 10 to 25 feet.

Lawrence: Some placed the depth at 10 feet, while others placed it at 20.

Haverhill: Opinion differs, varying from 14 to 22 feet, but the majority are in favor of a 22-foot depth. The Standard Oil Co. have a wharf and plant in the city of Haverhill, and at this point the company receives 853,196 gallons of gasoline and kerosene, or a total of 2,560 short tons. Even in the present state of the river it is possible for an oil-tank steamer to navigate the Merrimack as far as the works of the Standard Oil Co. in Haverhill.

Amesbury: The opinion expressed is that it should be 20 feet.

Newburyport: As to the depth of the river between its mouth and the city of Lowell, opinion was divided. Many men expressed the opinion that the depth should be at least 25 feet, while others went so far as to place the depth at 10 feet.

The record¹ of the United States hearing of October 4, which was held in Lawrence, and of the hearings given by the State Merrimack Valley Waterway Board at Newburyport, September 16, 1912; at Haverhill, November 25, 1912, at Amesbury, November 25, 1912; at Lawrence, November 26, 1912; and at Lowell, December 2, 1912, covers in the aggregate 232 typewritten pages of matter verbally presented. This office has also received many written statements bearing on the worthiness of the river for improvement either by

¹ Not printed.

the United States or by the Commonwealth of Massachusetts, or by the two in conjunction. As far up as Haverhill actual water-borne commerce exists, and statistics thereof will be given later in this report; but for the part of the river above Haverhill there is now no water-borne commerce, and the statistics quoted above and those contained in the reports of the hearings are the only basis on which to predicate what traffic may be expected to develop on the river, if the present lack of facilities be removed. There is a mass of testimony to the fact that railroad rates are abnormally high; that railway delivery is slow and unsatisfactory; that the people in general want a water line competing with the railroad; and that they would ship largely by water if such a line were opened and running regularly. Some testimony was offered to the effect that in the past as soon as a steamer began to run on the river, it was bought up and put out of service by those interested in the railroad. The main desire appeared to be for cheaper coal, but no one spoke at the hearings with authority to personally represent the great manufacturing concerns, who burn immense quantities of coal in auxiliary plants and who would appear to be specially interested in cheap fuel. At the United States hearing there was an engineer of the Essex Co., controlling all the dams and canals, but he had no authority to speak for the company, and said he was present to learn and not to instruct. I understand that at hearings on former preliminary studies of projects for the Merrimack River this has been the attitude of the power companies. On the other hand, the officers of that organization have thrown open to both the State commission and myself their records of gauge readings, discharges, maps, and drawings, and the making of full copies of such papers has been allowed without hesitation. In view of the intimate relations of their business to any change in hydraulic conditions in the Merrimack River, this free offer of facts and records is creditable.

Where such a mass of testimony is available it is not easy to present a just summary, but it is perhaps not unfair to state that careful study of the whole brings out the following salient facts: (1) The river is now utilized to its last drop for manufacturing; (2) millions of private funds are invested in the dams, canals, and factories; (3) dependent on the mills and living between Haverhill and Lowell is a population probably more dense than anywhere else along an equal number of miles of river, navigable or not, in the United States; (4) conditions of manufacturing are such that much of this dense population consists of foreigners of small means, in need of cheap fuel and cheap food; (5) not only is a large population of foreign origin concentrated in this area, but the capital locally invested in manufacturing is very large; (6) agricultural matters hardly enter appreciably into the question, the river farms being within hauling distance of the cities on the river; (7) the total length of river under consideration is only about 38 miles, and the annual value of manufactures along the upper 18 miles, the part above Haverhill, aggregates \$126,186,855, or at the rate of about \$7,000,000 per mile per annum; (8) a project forms no part of a preliminary examination, but sufficient facts have been obtained for this office by the State board to make it probable that at great cost deep-water navigation can be made physically possible to Lowell, or at least to the foot of

Hunts Falls, a mile and a half only below Lowell, within easy auto truck hauling of all coal consumers in that city; (9) the river is closed by ice for three or four months a year; (10) no matter what is done artificially to better matters freshets and violent currents prevent navigation for perhaps another month; (11) full commercial advantage has been taken of the water so far provided to Haverhill; (12) above the point where the tide ebbs and flows no fresh-water discharge is available for days at a time in the open-river season; (13) with small appropriations work up to this time has been piecemeal, has been executed with dredges so small as to be uneconomical in every way, and without suitable provisions for safe disposal of dredge spoil; (14) if deep excavation were undertaken, large dredges could work, and cheaper prices per yard might make the cost of a deep channel less than the comparison of yards to be removed would indicate.

10. *Economics of the problem.*—The wording of the act requires executive recommendation both as to the depth to be attained and the length of river to be improved; and these must be adopted before a logical decision can be reached as to worthiness or unworthiness. The act fails to indicate whether the same depth shall be provided for the upper part as for the lower; a simple recommendation to deepen Newburyport Bar and do no work elsewhere would apparently be a full compliance with the act. Successive examinations and surveys indicate that a slight increase of depth is not economical. Up to some point not yet determined the benefits of increased depth increase more rapidly than cost. Seven feet to Haverhill is seen to be too small; 12 feet was reported in 1905 as too small to confer benefits commensurate with the cost; in 1907 14 feet was reported to be worth \$890,000 by the local engineer officer, but not by higher authorities.

To secure and maintain depths on Newburyport outer bar greater than now exist involves the correct solution of the problem of improving an ocean channel across a sandy bar composed of easily moved sand, at the mouth of a fresh-water river of great variation in discharge, flowing through a sand-choked estuary of several miles length. Present depths on this bar appear to be sufficient for any commerce likely to develop, and to be successfully maintained by the present jetties; to secure greater depths would require their extension to a more or less indefinite extent, with considerable doubt as to ultimate results. It is recommended, therefore, that the present depths on the bar be adopted as the maximum limit for the improvement of the estuary and river above. The present bar admits steamers and barges of 17 feet draft at high tide. After passing over the bar the channel must be of a depth to permit such barges to reach a point of safe anchorage on the same tide on which they passed the bar. From that point upstream convenience demands 17 feet draft in the channel at low tide, but existing commerce shows that navigation can persist here even up to drafts nearly equaling the depths available at high tide, because the progress of the tidal wave up the Merrimack River is not far different from that at which tugs can tow barges. If 17 feet draft at mean low water be adopted for the inside channel, it would provide uninterrupted navigation for the deepest barges or steamers that can now enter over the bar.

In case the present jetties eventually secure depths over the bar even as great as 21 or 22 feet, a low-water channel accommodating 17-foot-draft vessels in the bay and river would permit the deepest vessels that could then enter to proceed "on the tide" as far upstream as the tidal range remained as great as 4 or 5 feet. For a decision as to worthiness or unworthiness, it seems wise to adopt for the tidal part of the stream a channel which at mean low water would have a minimum width of 200 feet and a minimum depth of 18 feet, such width and depth being considered suitable for boats of a maximum draft of 17 feet, for which the channel is designed. Tidal oscillation now ceases at Mitchells Falls, but prior studies indicate that resort to slack-water navigation may be necessary several miles below that point on account of the cost of excavation. The \$890,000 estimate corresponds with a depth in open channel of 14 feet to Lions Mouth and 14 feet slack water above to Haverhill, the level of the pool being so selected as to avoid interference with the tailraces at Lawrence, and the dam being of the movable type to give greater assurance against excessive backwater in time of freshets. As the pool level can not be raised higher than in the 14-foot project, the adoption of 17 feet draft, using a dam at Lions Mouth, would involve excavation in excess of the 14-foot project wherever that project did not provide excess depths; for instance, in the upper portion of the pool formed by the dam at Lions Mouth and for a considerable portion of the tidal section below that dam. From data now available exact estimates can not be made for either portion, as the character of material to be removed can only be determined by boring sufficiently to develop the amount of rock in place. The selection of Lions Mouth as the upper limit of an open dredged channel for vessels of 17-foot draft is subject to considerable doubt, however. That depth will admit vessels of much greater tonnage than the 14-foot project, and below Lions Mouth there is some very crooked and swift river, hard to negotiate with such large craft unless it be included in the pool of a dam farther downstream. By statute Haverhill marks the upper limit of the 14-foot channel, and by calling for a new survey extending higher up the river Congress has apparently approved the finding of the War Department that 14 feet to Haverhill is not worth \$890,000, and called for further study of the general question and cost and value of deep water in the Merrimack Valley, including Lawrence and Lowell in the problem.

The following discussion is based on the official figures for 1910, vouched for by the Massachusetts Bureau of Statistics and filed in the statehouse in Boston:

(a) *Newburyport as upper limit of improvement for 17 feet draft.*—Newburyport is credited with 53 manufacturing establishments, with aggregate capital of \$4,876,477, using annually \$3,951,983 worth of stock, paying annually \$1,581,543 to 3,156 people, and producing \$7,002,724 value of product. The necessary depth now exists on the bar, and a moderate amount of rock removal and dredging in the channel up to the highway bridge would give 17 feet draft at mean low water. Assuming that a survey does not develop excessive rock areas, it would seem that this work will be so comparatively inexpensive that it can be reported as worthy of being done by the

United States on condition that the State or municipality expend an equal sum in deepening the water between the United States channel and the wharves and in providing a suitable public terminal open to all water carriers on equal terms and connected with the railroad for interchange of water-borne and railroad-borne traffic.

(b) *Haverhill as upper limit of improvement for 17 feet draft.*—Haverhill and Newburyport both gain by such a project. Together they are credited with 378 manufacturing establishments, with an aggregate capital of \$19,375,039, using annually \$26,140,911 worth of stock, paying annually \$8,757,425 wages to 15,342 employees, and producing values amounting to \$42,653,554. For this portion of river we have as a guide the implied congressional decision that a 14-foot channel is not worth \$890,000. In his book on harbors, Stevenson has stated that in a harbor or river the commercial value of a channel varies as the cube of the depth, provided there is commerce available to utilize the depth. This is rational, as the cargoes carried by ocean vessels vary approximately with the cube of their draft, the general shape of such vessels being reasonably uniform. Seventeen feet draft will provide for ocean-going steamers and barges, and, assuming Stevenson's rule as a general guide, the 17-foot channel would be worth 1.8 times as much as the 14-foot. A channel to Haverhill costing \$1,600,000 and providing for vessels drawing 17 feet would then stand on a par with the 14-foot channel costing \$890,000, which did not appeal to Congress as a wise investment of public funds.

In the report of January 15, 1896, a 12-foot channel to Haverhill was, in round numbers, estimated to involve 1,300,000 cubic yards of dredging and 35,000 cubic yards of rock excavation. The dredging was estimated at 65 cents a yard, the rock excavation at \$15 a yard. The total cost, in round numbers, was put at \$1,500,000. The dredge price is too high for dredging a deep channel with powerful dredges. The rock price is not questioned, but the quantities of excavation are evidently so much greater for 17-foot draft than for 12 feet that no 17-foot dredged channel can probably be provided to Haverhill for less than \$1,600,000, the sum above indicated as a higher limit based on past congressional action. This plainly indicates that State or municipal cooperation must be a condition precedent to any work by the United States. In many cases in Massachusetts the State has already guaranteed the maintenance of channels provided by the United States. It would then seem not unreasonable to assume that if the State would guarantee maintenance of 17-foot draft to Haverhill at mean low water, and would contribute half the cost of the original improvement, the United States might be justified in putting not to exceed \$800,000 into a 17-foot-draft channel to Haverhill if a survey should indicate that such a channel could be provided for \$1,600,000. This view is influenced by the fact that, in view of the changes in dimensions of modern steamers and barges, a 17-foot channel is much better adapted to existing commercial conditions than a 14-foot channel, and hence has in reality more commercial value than the Stevenson rule of the cubes of the depths would indicate. The 14-foot project, using slack-water navigation above Lions Mouth, was estimated at \$890,000. It is possible that by dredging an additional 3 feet could be provided for the

\$710,000 remaining after deducting the cost of the dam, etc., from the assumed \$1,600,000 investment of State and United States, but large dredges could not work above the dam till the latter had created the pool, and small dredges are most uneconomical in the hardpan and boulders which form the bed of the river. It seems a reasonably open question whether open-channel navigation up to Haverhill would not in the long run be really the most economical to create and maintain. The above is sufficient to show that without a full and complete survey and borings in the bed of the river from the mouth up no fair report on the worthiness or unworthiness of a channel permitting vessels drawing 17 feet to reach Haverhill can be made.

(c) *Lawrence as upper limit of improvement for 17 feet draft.*—Lawrence, Haverhill, and Newburyport, all three, gain by such a project. Together they are credited with 507 manufacturing establishments, with an aggregate capital of \$99,032,610, using annually \$67,880,338 worth of stock, paying annually \$20,936,091 in wages to 43,325 employees, and producing values amounting to \$112,228,255. Above Haverhill the tide ebbs and flows as far as Mitchells Falls, but it seems probable that the cheapest and safest way to reach Lawrence is by a canal along the south bank of the river, carrying the level of the pool above the Lawrence Dam down as far as Ward Hill, which such a canal leaves on its northern side, and then locking down into the river proper about a mile above Haverhill. The State Merrimack Valley Waterway Board kindly made for this office an instrumental reconnoissance of this canal route, and there seems little doubt that it is cheaper than attempting channel excavation in the bed of the river. Slack-water navigation is out of the question in this reach without great injury to established water powers, upon which the prosperity of this section of the State depends. If the suggested canal be constructed to connect with the Lawrence pool, all the legal questions suggested under the antecedent head, "water power," at once arise. The canal would be about $6\frac{1}{2}$ miles long, and no excessive cuts or fills appear to be involved. If an estimate of \$250,000 a mile be admitted as a minimum, the cost would be not less than the cost of a 17-foot draft channel to Haverhill. Such a canal would open up to ocean vessels not only Lawrence but also the pool above the dam to within 2 or 3 miles of Lowell, so that one large coal-receiving plant could be established to supply by auto truck the needs of residents and smaller manufacturers in both Lowell and Lawrence. The larger mills in Lowell could perhaps be served by such a plant by electric freight service. The canal would in reality reach Lowell, and in considering the worthiness of the work Lowell statistics should be included. Newburyport, Haverhill, Lawrence, and Lowell all gain by such a 17-foot project. They are jointly credited with 741 establishments, with an aggregate capital of \$152,080,774, using annually \$102,210,308 worth of stock, paying annually \$34,389,169 wages to 74,774 employees, and producing values amounting to \$168,840,409. To carry deep water closer than a couple of miles of Lowell would cost out of all proportion to the benefits to be derived, unless some canal route can be found to connect the Lawrence pool with the Lowell pool in a manner similar to the suggested Lawrence Canal, thus opening up the river for a number of miles above Lowell.

That is a section not proper to consider in this report, but such a plan possibly offers real advantages, and is now understood to be under study by the State Merrimack Valley Waterway Board.

This fact leads to a suggestion that eliminates many of the legal difficulties raised under the head of water power. The cost of carrying 17 feet navigation above Haverhill and into the Lawrence pool can not well be less and is almost certainly greater than the cost to Haverhill, the head of tidal navigation, if a 17-foot draft open channel be dredged to that point. It would seem that if 17 feet is to be given above Haverhill it should be done by the State, which now, under State charters, has full control of the water-power situation. Such a cooperation on the part of the State or municipalities would be equivalent in effect to contributing at least half the cost of making Lowell and Lawrence seaports and would probably justify the United States in doing the work up to Haverhill or perhaps to 1 mile above Haverhill, where the State canal south of Ward Hill would enter the river. State control of such a canal would be advantageous in still another direction. The canal would develop a head probably 12 feet greater than is now available at the Lawrence Mills, and there might be possibilities of cooperation by the State and the Essex Co. looking to the utilizing of this added power, with less chance of legal complications than would result were the United States to build the canal. With a pledge from the State to complete a 17-foot draft canal from the Merrimack River 1 mile above Haverhill into the pool above the Lawrence dam and to operate the same free of tolls forever, it would then seem that the project of giving 17 feet draft to Haverhill at the cost of the United States might be a worthy one to be undertaken by the United States, if a survey does not show too great cost. To show more clearly the recommendations made up to this point the following table has been prepared:

Comparison of data for 17-foot draft channel with upper limits as stated below.

Upper limit.	Aggregate capital.	Aggregate annual stock.	Aggregate annual wages.	Aggregate employees.	Aggregate annual product.	Recommendation as to worthy or not.
Ward Hill near Newburyport.	\$4,876,477	\$3,951,983	\$1,581,543	3,156	\$7,002,724	Worthy if State spend equal sum in terminal and connecting channel.
Haverhill.....	19,375,039	26,140,911	8,757,425	15,342	42,653,554	Worthy if cost \$1,600,000 and State does half and maintains.
Pool between Lawrence and Lowell.	152,080,774	102,210,308	34,389,169	74,774	168,840,409	Worthy if State create and operate canal to Lawrence Pool.

In the above discussion nothing has been said as to possible reduction in cost by providing a less depth in the upper reaches. No recommendation for such a reduction can be made; it simply transfers from Newburyport to some place higher up the river the point where bulk cargoes of coal must be rehandled, and marks the limit of regular steamer service to Boston and New York. The cost of rehandling, the poor economy of small craft as compared with large, and the impossibility of profitably running river steamers for passenger and package freight for the few miles of river between Lowell and the mouth seem to make such reduction of depth in upper reaches en-

tirely impractical. As a unit by itself the Merrimack River has no appreciable value, its improvement as part of a route from the cities on its banks to Boston, New York, and the South has much value. Whether that value is commensurate with the cost involved can only be known by an actual survey, with numerous borings and accurate levels. The possibilities seem so great that I report without hesitation that the river is worthy of the cost of such a survey up to Ward Hill, about a mile above Haverhill. Above that point the surveys should be at State expense, as they are to do the work if the above recommendations are adopted by Congress.

11. *Interested parties.*—Every effort has been made by this office and by the State Merrimack Valley Waterway Board to get into close touch with all parties really interested in the improvement. A public hearing at Lawrence, the most central of the cities vitally interested in the river, was given by this office and was largely attended by a thoroughly interested and earnest body of representative men. The record of the stenographer's notes forms Appendix B¹ to this report.

Full typewritten records of the State board's hearings were filed with this office by the board, and have been carefully studied and considered in formulating my views. A large number of letters have been received. One of them, from the Lowell Board of Trade, presented at the hearing of October 4, 1912, states, among other things:

The interest of the people of the Merrimack Valley, and especially Lowell, in the project of making the river navigable is aroused when they realize that the cities of the Merrimack Valley are unable to compete with other manufacturing communities enjoying water-transportation facilities. * * * The Merrimack River turns more spindles than any other river in the world, * * * the Merrimack River flows through the greatest textile center of the United States. * * * The Board of Trade of Lowell agree that the improvement of the Merrimack River will develop new territory, will enhance the value of land and real estate, will reduce the cost and increase the efficiency of transportation, and will have a tendency to decrease the cost of living and open new fields for the employment of capital and labor.

Under date of September 19, 1912, Mr. J. O. Ellison, of Haverhill, writes:

I have been managing a steamer 170 feet long, 32 feet wide, on a draft of 10½ feet, and have been coming to Haverhill for three years with very little trouble. * * *

I have had exceptional interest shown by the business men of Haverhill and all other places of any importance along the Merrimack River, and also including Gloucester, Lynn, Salem, and Beverly, along the line of putting on boats for general freight to New York.

Under date of September 7, 1912, Mr. Fred L. Atkinson, of Newburyport, writes:

I am actively engaged now, and have been since 1884, in the wholesale coal business * * *.

In about 1886 I saw moved 22,000 tons of coal in one season from Newburyport to Lawrence and Lowell by lighter over Mitchells Falls by the Pentucket Navigation Co. (so called, Hon. Benj. F. Butler and Hon. E. Moody Boynton), with an expenditure of a few thousand dollars at the falls.

Under date of August 19, 1912, Mr. Levi L. H. Taylor, of Haverhill, writes:

What we want is either a lock dam at Lions Mouth or river dredged so we can have 18 feet at low water. The barges of Standard Oil come to Haverhill; also tugs towing coal scows, but only on high water.

¹ Not printed.

Under date of September 17, 1912, Mr. Henry C. Long writes:

I will say that the State of Massachusetts and the Merrimack Valley stands ready to put up two millions of money to provide terminals and to connect them with the channels, if the United States Government will make a channel. I should say it—the channel—ought to be at least 300 feet wide and of sufficient depth for vessels drawing 20 feet; nothing less will be of any value. * * * There is, perhaps, not another waterway in the world of equal length upon the banks of which exists so much commerce waiting for a channel to use it.

Under date of September 18, 1912, Mr. William J. Ward, proprietor of the Merrimack River Boat & Canoe Co., writes:

The Merrimack is free of ice from the middle of March to the middle of December, approximately—a period of nine months. Freshets are few and of short duration. Seven feet is the greatest rise above the dam at Lawrence recorded (Essex Co. records). [Apparently an error.] Average freshet rise, about $4\frac{1}{2}$ feet. Duration of freshet, three to six days. Usual number of freshets each year, one shortly before or after April 1. Rarely have others in mid-summer and fall, * * * Current at freshet time, 7 to 14 miles per hour, according to place—usually 7 or less. Merrimack is navigable its entire length from Lowell to the sea for a boat drawing 6 feet of water when a freshet is on, as has been proven (1886, *Startled Fawn*). Gen. B. F. Butler, of Lowell, operated an experimental freight line from Newburyport to Lowell in early eighties or late seventies (reference, L. C. Prouty, 35 Marginal Street, Lowell). * * * From the Lawrence Dam to a point east of Lowell called McMannons or Richardson Brook the depth is ample and free from obstructions, save a small submerged island on the north side 100 feet southwest of the head of Pine Island. * * * From Richardson Brook west to the foot of Hunts Falls in Lowell is a middle ground similar to that between Lawrence and Mitchells Falls. Through this a channel extends, partly obstructed by silt and sewage deposits. The distance of middle ground is about $1\frac{1}{2}$ miles. Thirty-five years ago a side-wheel steamboat navigated between Lawrence and the foot of Hunts Falls in Lowell. Boat drew 2 or 3 feet of water.

Under date of September 18, 1912, the Haverhill Box Board Co. writes:

Our plant is located in the city of Haverhill on the southern bank of the Merrimack River. It is located very close to the river, where we can practically handle freight received by water as cheaply as if it came by rail. * * * With the channel as proposed, this coal could be delivered to our plant in the original barges or schooners in which it is shipped at the same or a slight increase in the cost of delivering it to Newburyport. Any extra charge for delivering at Haverhill would be more than offset by the loss which we now have in transferring the coal at Newburyport and the damage to it by the extra handling. We, therefore, figure we would have a saving of 57 cents per ton on our annual consumption of 27,000 tons, which would amount to \$15,390.

On our raw materials this smallest annual saving which we could hope for would be as follows:

5,000 tons paper stock from New York, \$1 per ton	\$5,000
15,000 tons paper stock from Boston, \$0.50 per ton	7,500
2,000 tons wood pulp, \$3 per ton	6,000
3,000 tons sulphite, \$1.50 per ton	¹ 1,500
1,000 tons rosin, alum, twine, starch, and miscellaneous supplies, \$1.50 per ton	1,500
	21,500

Out of a consumption of 48,000 tons of raw material we are only figuring on shipping one-half of it by water. * * *

Regarding our finished product, estimating that we could ship one-third of our output by water—and more than that amount is always shipped to the following terminals:

5,000 tons to New York, at \$1.50 per ton	¹ \$5,000
10,000 tons to Boston, at \$0.50 per ton	5,000
	10,000

¹ Computation incorrect.

* * * I might add that at the present time it requires from 10 days to 2 weeks to deliver paper to New York. With the above transportation our goods could be landed in Boston the day following and in New York on the second day. You will realize the importance of these quick deliveries, as it often means the leverage by which business is secured. * * *

In recapitulating the saving I have here given you would be as follows:

Estimated saving:	
On coal.....	\$15,390
On raw materials.....	21,500
On finished product.....	10,000
Total.....	46,890

As this plant is only one of the great number on the Merrimack River, I feel assured if the other manufacturers interested will make up such a statement you will find that the United States Government can afford to expend quite a handsome sum in deepening the Merrimack River from Lowell to the sea.

Under date of September 20, 1912, the Haverhill Board of Trade submitted a number of statistics, which are appended to this report, marked "Appendix C."¹

Under date of December 19, 1912, Mr. Leslie K. Morse, president of the Merrimack Valley Waterways Association (not the State board), wrote me a letter suggesting the termination of the channel a short distance above Haverhill to connect with a proposed bridge and highway to give autotruck service to Lawrence. This letter is appended, marked "Appendix D."¹

Under date of January 28, 1913, the State Merrimack Valley Waterway Board submitted its report to the Massachusetts General Court and courteously supplied me with a copy, which is appended hereto, marked "Appendix E."¹

12. *Commerce.*—The following statistics, compiled for the fiscal year 1912 for use in the Annual Report of the Chief of Engineers for 1913, have been collected from the freight-carrying interests on the river:

Vessel classification.

Class.	Ameri- can.	Total net regis- tered tonnage.
Registered:		
Steamers.....	10	5,550
Sailing vessels.....	1	318
Barges.....	10	3,572
Total.....	21	9,440

Freight traffic.

Articles.	Amount (cus- tomary units).	Short tons.	Valuation.	Carried to—	Average haul or distance carried.	Rate per ton-mile.
	<i>Tons.</i>				<i>Miles.</i>	
Coal.....	69,823	69,823	\$379,706.65	Haverhill.....	16	² \$0.022
	1,728	1,728		Groveland.....	13	.027
	4,487	4,487		Merrimac.....	9	.028
	5,210	5,210		Amesbury Ferry.....	5	.020
	2,494	2,494		Amesbury Mills.....	6	.050
	94	94		West Newbury.....	10	.035
Oil.....	<i>Barrels.</i> 17,062	2,815	59,000.00	Haverhill.....	16	.016
Total.....		86.651	438,706.65			

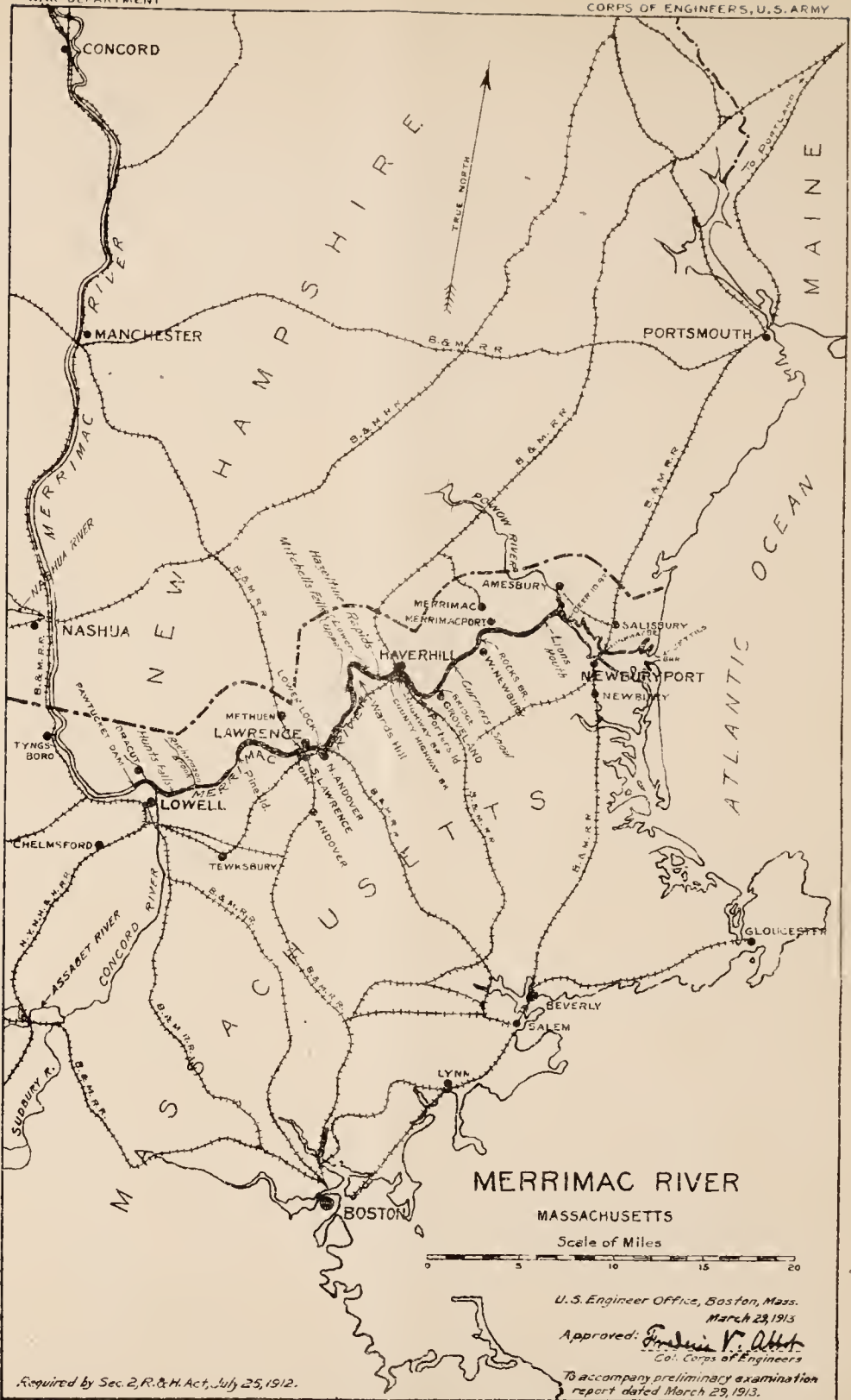
¹ Not printed. ² There is also a 25 cents per ton transferring charge at Newburyport.

13. *Survey.*—Whether the creation of a channel 18 feet deep and 200 feet wide, suitably widened at the bends, which will safely permit 17-foot draft vessels to navigate the river is practicable is largely a matter of cost. If the material can be removed by powerful dredges, without drilling and blasting, the cost may or may not be excessive, depending on the yardage, which can be ascertained only by an accurate hydrographic survey from the bar to the point opposite Ward Hill, where it has been recommended above that the United States turn over the river to the State for improvement. If large quantities of rock are found by boring it may be necessary to combine dredging and slack-water navigation below Ward Hill; accurate and numerous borings are therefore unavoidable before any definite project or any approximation to the cost of such a channel is possible. While there are reliable maps of portions of the river there are long reaches for which no reliable data are available. It is intended to avoid duplicating work by using such known data as are available and supplementing them by new surveys.

The question of cost must be determined within reasonable limits before it is known to what extent cooperation by the State should be asked; it seems, therefore, that the United States should make an accurate survey of the river up to Ward Hill, provided the State will undertake a similar survey for a canal from Ward Hill to connect with the pool above the Lawrence Dam. It is understood that there is a considerable State appropriation now available for such a survey, and there is little doubt that the balance would be provided by the Commonwealth of Massachusetts if such provision was made a condition precedent to a survey up to Ward Hill by the United States. By following this course cooperation by the State and the Federal Government would begin at the very start, and there would be good ground for confidence that the local authorities were thoroughly in earnest, and that the improvement was worthy of being made by the State and the United States jointly.

It is therefore recommended that an allotment for a United States survey of the Merrimack River from Black Rocks Beacon up to Ward Hill, with a view to the creation of a channel 200 feet wide and 18 feet deep at mean low water, suitably widened at the bends, be made; its expenditure to be conditional upon the provision by the State of sufficient funds for the making by competent State authority of an accurate survey for a canal to afford 18 feet depth and 200 feet width, suitably widened at the bends, connecting the pool above the Lawrence Dam with the channel of the Merrimack River just below Ward Hill. Under no conditions should the United States undertake to make a survey above Ward Hill, even if the State offers to defray the cost; for the legal questions as to State and Federal relationships to water powers on that part of the river are so involved that the whole matter of the extension above Ward Hill, survey as well as construction, operation, and maintenance of the canal, should be strictly the State's contribution to the improvement of the river.

FREDERIC V. ABBOT,
Colonel, Corps of Engineers.





[First indorsement.]

OFFICE OF DIVISION ENGINEER,
NORTHEAST DIVISION,
New York, N. Y., April 8, 1913.

TO CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. Attention is invited to the inclosed copy of correspondence with the district officer. The change requested by the district officer in his indorsement has been made. It is my opinion that the project for the improvement of the Merrimack River should include the deepening of the channel of the bar at its mouth, and that the studies for this project should include whatever studies are necessary for a recommendation for such deepening.

2. Subject to the above, the recommendations of the district officer are concurred in.

W. M. BLACK,
Colonel, Corps of Engineers.

[Third indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
May 20, 1913.

TO CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. From the facts presented herein, the board believes that the question of advisability in this case can be determined only after the results of a survey have been made known, and it therefore concurs with the district officer and the division engineer in recommending the authorization of a survey of the Merrimack River from the mouth to Ward Hill, to be made under the condition that the State shall make an accurate survey and prepare a project, with estimate of cost, for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell.

2. The board recommends that the survey to be made by the district officer shall include studies for a channel over the bar at the entrance to the river of suitable depth to accommodate a draft of 17 feet at mean low water.

For the board:

WM. T. ROSSELL,
*Colonel, Corps of Engineers,
Senior Member of the Board.*

SURVEY OF MERRIMACK RIVER, LOWELL TO THE SEA.

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 10, 1914.

From: The District Engineer Officer.

To: The Chief of Engineers, United States Army.

(Through the Division Engineer).

Subject: Survey of Merrimack River, Mass.

1. In compliance with instructions contained in your letter dated May 23, 1913, the following report is submitted on the survey of

Merrimack River, Mass., with a view to securing increased depth from Lowell to the sea or in any part of this section of the river.

These instructions were accompanied by the following recommendations of the Board of Engineers for Rivers and Harbors, dated May 20, 1913, which the Chief of Engineers directed be complied with:

1. From the facts presented herein, the board believes that the question of advisability in this case can be determined only after the results of a survey have been made known, and it therefore concurs with the district officer and the division engineer in recommending the authorization of a survey of the Merrimack River from the mouth to Ward Hill, to be made under the condition that the State shall make an accurate survey and prepare a project, with estimate of cost, for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell.

2. The board recommends that the survey to be made by the district officer shall include studies for a channel over the bar at the entrance to the river of suitable depth to accommodate a draft of 17 feet at mean low water.

2. In the preliminary examination report a survey of the river up to Ward Hill was recommended—

with a view to the creation of a channel 200 feet wide and 18 feet deep at mean low water, * * * conditional upon the provision by the State of sufficient funds for the making by competent State authority of an accurate survey for a canal to afford 18 feet depth and 200 feet width, * * * connecting the pool above Lawrence dam with the channel of the Merrimack River just below Ward Hill.

Assurance satisfactory to the Secretary of War was given by the proper authorities of the Commonwealth that it would make the survey and prepare a project and estimate of cost of an 18-foot channel of suitable width from Ward Hill to Lowell. This survey on the part of the Commonwealth was conducted under the direction of the Merrimack Valley Waterway Board, whose report, printed as State Document No. 2169, January, 1914, is herewith.¹

3. The route suggested in the preliminary examination report (p. 41) between Ward Hill and Lawrence was by canal along the south bank of the river, carrying the level of the pool above the Lawrence dam downstream as far as Ward Hill, which such a canal leaves on its northern side, and then locking down into the river proper about a mile above Haverhill. After investigating this route, however, the Merrimack Valley Waterway Board reported that—

The conclusion reached by the board was that, owing to the land damages, which would amount to a large sum, the cost of necessary bridges at various streets in North Andover and South Lawrence, the re-laying of sewers, water mains, and car tracks, the large amount of water which would be required in the canal, and particularly as such a canal would not, in the judgment of this board, best serve the business interests of Lawrence, a channel dredged in the river and canals constructed across Ward Hill and at the Lawrence dam would be a better solution of the problem.

The project proposed by the Merrimack Valley Waterway Board is for a lock below Ward Hill at the termination of the proposed United States channel, and a canal back of Ward Hill, connecting at the upstream end of Kimballs Island with a pool 12.71 feet above 0.0 at Black Rocks Beacon; this pool being maintained by a dam above Mitchells Upper Falls and below Kimballs Island, and extending up to Lawrence, where another lock would carry vessels

¹ Printed in part at the end of this document (see p. 143).

into the pool of the existing Lawrence dam, which is to be deepened by dredging to carry 17 feet draft up to Hunts Falls, Lowell, about 2 miles below the city proper.

The State board estimated the cost of its project at \$5,443,600, exclusive of land damages at Ward Hill, of the cost of removal of Broadway Bridge at Lawrence, and of the construction of a new bridge at that point, and of the cost of making certain changes in existing bridges between Ward Hill and Broadway Bridge.

4. As outlined in the preliminary examination report, the survey by the United States was conducted with a view to obtaining a tidal channel of 18 feet depth at mean low water from the sea to Ward Hill: but the results of the survey, as shown by the estimate below, clearly indicate the cost for a tidal channel to be prohibitive. The survey included sounding the entire section of the river from the bar **at its mouth up to Ward Hill**, numerous borings in the probable location of the proposed channel, and tide observations in the section **of the river from Haverhill to Ward Hill**.

5. The river in its present condition has a channel of navigable width and at least 13 feet deep at mean low water across the bar and in to Black Rocks Beacon, a distance of about $1\frac{1}{2}$ miles; at least 9 feet deep at mean low water, thence to the bridges at Newburyport, a distance of about $2\frac{1}{4}$ miles; at least 14 feet deep at mean low water, thence to a point locally known as the Lions Mouth, a distance of about $3\frac{3}{4}$ miles; and thence at least 7 feet deep at mean low water to the railroad bridge at Haverhill, a distance of about 13 miles. Above the railroad bridge the channel has a greatest continuous depth of about 4 feet at mean low water, is narrow and tortuous, is studded with many and large bowlders, and is not navigated. From the railroad bridge to a junction with the proposed State channel at Ward Hill the distance is 2 miles.

Throughout the stretch included in the survey the river has but one tributary of navigable proportions, Powow River, which enters the Merrimack from the north at a point about $3\frac{3}{4}$ miles above Newburyport. Powow River has a channel 12 feet deep at mean high water or about 5 feet at mean low water, is about $1\frac{3}{4}$ miles long, and at its upper end are located the wharves of Amesbury.

Excavation would be necessary in $20\frac{1}{2}$ miles of the $22\frac{1}{2}$ miles of channel between the bar and Ward Hill to secure a tidal channel 18 feet deep at mean low water. The material as developed by the borings proved in the main to be sand and gravel with occasional clay. Rocky formation above 18 feet depth was located at 34 places along the river bed, and in such quantity as to be the cause of a very large part of the cost of a tidal channel. The position and extent of these rocky areas is shown upon the plans. In the reaches of the river between Haverhill and the sea the greater masses of rock are found at Deer Island, Merrimacport, Rocks Bridge, Curriers Shoal, and along the waterfront of Haverhill.

Above Haverhill to Ward Hill large quantities of rock were located and in the upper 3,500 feet of the channel around the base of Ward Hill and passing through Hazeltine Rapids the underlying rock becomes practically continuous. The rock cut here is so large that it has been given separate consideration in the estimates on the

supposition that it could be removed under cover of cofferdams instead of by the usual method of subaqueous rock excavation.

6. The upper part of the river is subject to erratic fluctuations of the water surface at times of low-water stages, due to the retention of practically all flow of the river behind the dam of the Essex Co. at Lawrence except such quantity as passes through the mills when running.

Observations taken in 1914 give a mean low water determination at Haverhill Bridge of 0.74 foot lower than that of 1905, but the lowest tide observed was but 0.12 foot lower than the lowest of the observations of 1905. To insure a least depth of 18 feet in the upper section of the channel at low-water stages of the river, it appears necessary to adopt this lowest observed level, which is 1.87 feet below local mean low water of 1905 at Haverhill Bridge and 2.27 feet above 0.0 at Black Rocks beacon, as the plane of reference in the upper part of the river, and the estimates are based on a channel 18 feet deep below this plane. In the lower part of the river where the tidal influence is greater the bottom is made parallel to the mean low-water slope.

7. Opposite the lower end of the water front at Newburyport the channel is obstructed by extensive rock formation locally known as Gangway Rocks. A channel 9 feet deep at mean low water has been obtained here by cutting down these ledges, but it was known that the cost of a further increase in depth to 18 feet would be so great that search was made by boring for a more favorable location for the 18-foot channel. It was found practicable to swing the proposed channel about 700 feet south around this ledge area, avoiding practically all ledge excavation. The advantages of this change are the saving of about \$57,000 in cost of the channel, and in locating it for an additional length of about 2,000 feet close along the water front of Newburyport, giving deep water close to the wharves for that length which would not be obtained if the location of the former channel was adhered to. The only disadvantage of the change is the introduction of one additional bend in the channel. This change has been adopted in the estimates.

8. The estimate of cost of a tidal channel from Black Rocks Beacon to Ward Hill is as follows:

Dredging 8,808,457 cubic yards of sand, gravel, and clay, at 40 cents_____	\$3, 523, 382. 80
Rock excavation, Ward Hill section, 312,208 cubic yards, at \$4____	1, 248, 832. 00
Rock excavation, below Ward Hill section, 378,798 cubic yards, at \$8_____	3, 030, 384. 00
Boulder excavation, below Ward Hill section, 62,332 cubic yards, at \$2.50_____	155, 830. 00
	7, 958, 428. 80
Engineering and contingencies_____	541, 571. 20
Total_____	8, 500, 000. 00

9. The project for a tidal channel was found so costly that the question of obtaining the required depth by the means of a dam was then considered. In 1908 Col. Edw. Burr submitted a project of this nature with a view to providing by lock and dam a channel 14 feet deep from the mouth of the river to the railroad bridge at Haverhill. (H. Doc. No. 2, 61st Cong., 1st sess.) His conclusions were

that this could be accomplished by a lock and dam located a short distance above the Lions Mouth; the level of the pool above the dam to be 11.14 feet above 0.0 at Black Rocks Beacon; and that a pool at this level would not injuriously affect the water power of the Essex Co., at Lawrence, Mass., nor cause excessive flowage damage along the banks of the river. The engineers of the Merrimack Valley Waterway Board, who proposed a dam above Mitchells Falls to maintain a pool having a surface level of 12.71 feet above 0.0 at Black Rocks Beacon, adopted this level, having in consideration noninterference with the water power at Lawrence. If the water power at Lawrence will not be interfered with by this dam it appears practicable to raise the pool level at the proposed dam at Lions Mouth to elevation 12.71 feet adopted by the State engineers for their pool and maintain a practically level pool in the stretch of river between Lions Mouth and Mitchells Falls. If this be done the lock and dam proposed by the Merrimack Valley Waterway Board to pass around Mitchells Falls, and estimated to cost \$1,117,000, would be eliminated, and the work of the State in this locality would be reduced to an open cut of suitable dimensions either through Mitchells Falls or by route of the cut-off canal at present proposed in connection with their plan of lock and dam.

10. The estimate adopting a dam at Lions Mouth to maintain a pool at grade 12.71 feet above 0.0 at Black Rocks Beacon is as follows:

Tidal channel from Black Rocks Beacon to the dam:

Dredging 1,064,524 cubic yards, at 40 cents-----	\$425, 809. 60
Rock excavation, 19,833 cubic yards, at \$8-----	158, 664. 00
	584, 473. 60

Excavation above dam to Ward Hill:

Dredging 945,709 cubic yards, at 40 cents-----	\$378, 283. 60
Rock excavation, Ward Hill section, 72,298 cubic yards, at \$4-----	289, 192. 00
Rock excavation, below Ward Hill section, 3,405 cubic yards, at \$8-----	27, 240. 00
	694, 715. 60
	1, 279, 189. 20

Dam at Lions Mouth:

Foundation of dam-----	350, 000. 00
1,100 lineal-foot movable dam-----	412, 500. 00
Lock, etc-----	487, 500. 00
	1, 250, 000. 00

2, 529, 189. 20

Engineering and contingencies----- 220, 810. 80

Total----- 2, 750, 000. 00

For the purposes of estimate, the size of lock adopted by the State, 45 by 350 feet, with 18 feet depth on the miter sill, has been used; but, in my opinion, longer and wider locks, with deeper water on the sill, should be provided at the start if the improvement were undertaken.

11. The question of locating the proposed dam below the mouth of Powow River in order that Amesbury might be benefited by the increase in depth of channel of the Powow River was also considered. A suitable location for a lock and dam can be found below Deer Island bridge by utilizing the passages between the islands, about 3

miles below, and would result in some reduction of cost as applying only to the problem of obtaining 18 feet depth of water; but dikes would be necessary to hold the pool level in the vicinity of the islands below Deer Island bridge, and the flowage damages would be greatly increased by this change in location of the dam. At Amesbury, at the head of navigation in Powow River, a water power of about 240 horsepower would be seriously interfered with, and practically all the wharves of the town and the basements of several industrial plants would be submerged. At the mouth of the Powow River two coal wharves would be submerged, and on the left bank of the Merrimack River for about three-fourths of a mile above and three-fourths of a mile below the mouth of Powow River flowage would occur to a limited extent in a thickly settled section. This flowage would occur with pool level either at 11.14 or 12.71 feet above 0.0 at Black Rocks Beacon. For the reasons above stated and because the water front of South Amesbury (Salisbury Point) on the banks of the Merrimack is only about 1 mile distant by highway from Amesbury, the construction of a dam below the mouth of Powow River is considered inadvisable.

12. The channel lines laid down on the accompanying plans, in seven sheets, locate a channel 200 feet wide, in straight sections, suitably widened at the bends, 18 feet deep at mean low water, considered suitable for barges of 17 feet draft. This location, while primarily laid down for the tidal channel, is also the most advantageous location for a channel in the pool of the dam.

13. A serious objection to the use of a dam in the improvement of the river is its probable effect on the maintenance of the channel over the bar at the mouth of the river. The river is a tidal stream up to the foot of Mitchells Upper Falls, and a dam located at Lions Mouth would exclude the tide for about two-thirds in length of this tidal section of the river.

Approximate computation, based on such information as is available shows the entire tidal prism of the river above the gorge at Plum Island to be 1,090,000,000 cubic feet, and that of the section above the dam at Lions Mouth to be 377,000,000 cubic feet; or it may be said that a dam at Lions Mouth cutting off two-thirds of the length of the tidal river will reduce the tidal prism one-third. This reduction of tidal prism will be of advantage in the upper part of the remaining tidal channel, as the current will be reduced in velocity at several difficult bends, particularly in the vicinity of Deer Island Bridge, where tidewater will be reduced to about one-fifth of the quantity that passes at present. Its effect, however, on the improvement of the bar at the mouth of the river will be distinctly detrimental and will probably necessitate modification of the present project for improvement of Newburyport Harbor and possibly periodical dredging to compensate for the loss of scouring power.

14. The jetties now maintain about 13 feet depth at mean low water, with promise that recent additions to the north jetty will produce more depth when conditions become permanent. While the tidal scour is slow and partial in its effect, this can probably be made reasonably certain and be more promptly accomplished by the use of a pump dredge, in the first place cutting the bar down to a depth of about 24 feet. This extra depth of 6 feet would in the end be an economy,

as it would enable a larger and more economical dredge to be used for maintenance of the bar; it would by the greater depth reduce the wave action on the bottom, and would also concentrate the flow of the tide better in the channel and so increase the maintenance effect of the currents.

Below Black Rocks Beacon over the bar to deep water the improvement under consideration falls within the project of improvement of Newburyport Harbor by jetties at the mouth of the river.

In 1880, before the construction of jetties was commenced, the 18-foot curves inside and outside of the bar were 4,300 feet apart.

In 1901 a continuous 18-foot channel with least width of 200 feet extended from the gorge between Plum Island and Salisbury Beach seaward for 300 feet beyond the present seaward end of the jetties, and the 18-foot contours inside and outside of the bar were 1,200 feet apart.

In 1909 the 18-foot curves inside and outside of the bar were 1,000 feet apart, and inside of the north jetty a break 600 feet long existed in the 18-foot depth.

The channel inside of the jetties in both 1901 and 1909 swept from the gorge through a wide curve to the north around a shoal which ran out northeasterly from the north end of Plum Island. This swing first developed in 1891 and continued through to 1909.

In 1909 the south jetty had been completed excepting about 30 feet in length of its outer 1,000 feet of parallel arm; the north jetty was completed practically out to the point of parallelism with the south jetty. In 1910 extension of the north jetty was commenced, and early in 1912 a core of the work up to full grade had been completed. In 1913-14 this core was completed to full cross section.

15. Changes for the better in general conditions of the work followed on the progress of extension of this jetty. In 1914 the 18-foot contours inside and outside of the bar were 525 feet apart, but inside the north jetty the same interruption of the 18-foot contour existed as in 1909, the break being 800 feet long. But the most pronounced improvement in conditions is in the shifting of the shoal extending northeast from Plum Island, which in the 6-foot contour has swung 825 feet south and apparently is still in motion. On a 12-foot depth the channel has broken through and maintained itself parallel to the 6-foot change, but at this depth the channel following the swing of deeper water to the northeast is the better as yet.

16. It is thus shown that the discharge of the river has maintained from 1901 to 1906 a channel 18 feet deep from the gorge outward past the ends of the jetties, but interrupted between that point and the ocean by a bar with only 13 feet depth at mean low water, and that the completion of the parallel arms has developed a decided tendency for the channel to straighten into a general east and west course, eliminate the curve inside of the jetties, and scour off the shoal extending northeast from Plum Island; also that the distance between the 18-foot contours inside and outside of the bar is rapidly diminishing. Current observations show that on the ebb tide the discharge from the main channel of the river on the north and from over the extensive flats on the south meet at the gorge between Plum Island and Salisbury Beach and that the resultant is a current setting northeasterly, accounting for the curved sweep to the northeast

of that part of the channel between the gorge and the north jetty. Only in the last hour of ebb tide, when the discharge from the flats on the south is nearly exhausted, does the resultant current from the gorge flow directly eastward in line with the parallel arms of the jetties.

The tendency toward a straightening and deepening of the channel at the mouth of the river as outlined above, as a result of the recent extension of the north jetty, indicates that this portion of the improvement might well be left to await the effect of such extension while the other works were being built. Should the jetty improvement prove insufficient in its final effect, resort may be had to dredging the bar, which was authorized by the act of January 25, 1910, as part of the project for Newburyport Harbor, under which project suitable action may be taken to accomplish the required depth.

17. Another serious question to be considered is the effect of a dam in a river so polluted with sewage as this stream is at the present time, receiving, as it does, the sewage of many large cities and towns which line its banks. The pondage of this sewage during low-water stages in the summer season might be a serious menace to the public health, particularly during periods when the mills at Lawrence are shut down Saturdays and Sundays, when the entire flow of the river is stopped. (See preliminary examination report.)

18. The preliminary examination report suggested, and the allotment for the survey was based on, a physical division of the improvement between the Commonwealth and the United States—the latter to make the improvement up to Ward Hill and the Commonwealth from there to Lowell. For the reasons stated in said report, this division should be adhered to if the improvement of any part of the river is to be undertaken by the United States. As shown by the estimates, this means that the United States should bear approximately \$2,750,000 of the cost and the Commonwealth or local interests \$1,326,600, plus all costs of land damages, including flowage rights, bridge removal and reconstruction at Lawrence, terminals, etc. The construction of a dam at Lions Mouth would relieve the Commonwealth of the necessity for a dam at Mitchells Falls and lock at Ward Hill, which the Merrimack Valley Waterway Board estimated would cost \$1,117,000.

19. The conclusions and recommendations of the Merrimack Valley Waterway Board, as set forth in its report, were in part:

(a) That the Merrimack River should be improved and opened to navigation by providing a channel 18 feet deep at mean low water extending from the sea to Ward Hill, about 1 mile above Haverhill, and by providing a depth of 18 feet by means of a channel, and by building canals and locks from Ward Hill to Hunts Falls, at Lowell.

(b) That the Federal Government carry into effect a project providing for a channel 18 feet deep at mean low water from the sea to Ward Hill, about 1 mile above Haverhill, and that the Commonwealth of Massachusetts cooperate with the Federal Government in carrying such project into effect, the basis, form, and method of cooperation to be agreed upon after all facts and data have been obtained.

(c) That the Commonwealth of Massachusetts adopt and carry into effect the project prepared by the Merrimack Valley Waterway Board for the improvement of the Merrimack River from Ward Hill, about 1 mile above Haverhill, to Hunts Falls, at Lowell, substantially as outlined in this report, namely, by excavating a channel of adequate width and 18 feet deep in the river and by building locks and canals to provide a depth of 18 feet, and that the Federal Govern-

ment cooperate with the Commonwealth of Massachusetts in carrying such project into effect, and that the basis, form, and method of cooperation in respect to the State's project be agreed upon at the same time as agreed upon in respect to the Federal Government's project for improvement of the river as far as Ward Hill.

* * * * *
(g) That an appropriation of \$1,000,000 be made by the legislature for the purpose of improving the Merrimac River and, as evidence of agreement by the Commonwealth to a policy of cooperation with the Federal Government with respect thereto, the expenditure of this appropriation to be conditioned upon the passage by Congress of appropriations for the same purpose.

In pursuance of these conclusions and recommendations the following act was passed by the Legislature of Massachusetts on June 20, 1914 (ch. 691, 1914) :

AN ACT To provide for the improvement of the Merrimac River.

Be it enacted, etc., as follows:

SECTION 1. Under the direction of the board of harbor and land commissioners a sum not exceeding \$1,000,000 may be expended for the improvement for navigation of the Merrimac River from the sea to Hunts Falls at Lowell by the construction of a channel therein: *Provided*, That no part of said sum shall be available or expended until the Congress of the United States shall approve a project and make an appropriation therefor to improve that part of said river from the sea to a point opposite Wards Hill, about one mile above Haverhill, so that a continuous channel will be provided throughout this part of said river not less than eighteen feet deep at mean low water and of adequate width.

SEC. 2. To meet the expenses that may be incurred under the provisions of this act the treasurer and receiver general is hereby authorized, with the approval of the governor and council, to issue bonds, scrip, or certificates of indebtedness to an amount not exceeding \$1,000,000, for a term not exceeding forty years, to be in such form, to bear such rate of interest, and to be issued in such amounts from time to time as the treasurer and receiver general, with the approval of the governor and council, shall determine.

SEC. 3. This act shall take effect upon its passage.

Approved, June 20, 1914.

20. The report of the Merrimack Valley Waterway Board gives the following summary of statistics concerning the cities and towns along Merrimack River:

Total population-----	307, 540
Total value of assessed estates, Apr. 1, 1913-----	\$262, 710, 204
Total number of establishments-----	814
Total capital invested-----	\$188, 152, 336

This represents about 53.1 per cent of the capital invested in metropolitan Boston (including Boston and 39 other cities and towns) and about 14.4 per cent of that invested in the whole State.

Total value of stock and material used-----	\$116, 870, 360
---	-----------------

This represents about 36.5 per cent of that of metropolitan Boston and about 12.6 per cent of that of the whole State.

Total amount of wages paid during the year-----	\$42, 004, 459
Total number of wage earners employed during year-----	85, 069
Total value of product-----	\$196, 595, 077

This represents about 36.1 per cent of the total value of product of metropolitan Boston and about 12.4 per cent of that of the whole State.

The total coal consumption of these cities and towns exceeds 1,200,000 tons, only about 135,000 tons of which is now received by water. In the opinion of the manufacturers along the river an adequate water route for the receipt of

this commodity would effect a saving in freight rates of from 50 cents to \$1 a ton, in addition to the saving in transportation charges on general merchandise, raw material, and manufactured product.

Supplementing these statistics, Mr. Andrew B. Sutherland, of Lawrence, a member of the former Merrimack Valley Waterway Board, writes this office, under date of July 31, 1914, as follows:

As you will soon complete borings on the Merrimack River, and as your report to Washington must necessarily follow, it is the hope of the people of this valley that you will report favorably to the Federal Government to recommend the work providing an 18-foot channel from the mouth of the river to Lowell, seeing that the State has made a liberal contribution of \$1,000,000, and the cities on the banks of the river have guaranteed to construct terminals open to everyone on equal terms and not controlled by the railroad. In view of these facts it would seem that we ought to have a favorable report, and especially when the following schedule of traffic is considered. We have in the valley, between the New Hampshire line and the sea, in the cities and towns adjoining the river, a total population of 307,540. The value of raw material brought in to be manufactured is \$116,870,360, which turned out as a finished product amounts to \$196,595,077, making a grand total of what you might term of imports and exports to the value of \$313,465,437. That is not including coal, of which we consume 1,200,000 tons; neither does it include foodstuffs, merchandise, etc., but simply the value of the raw materials brought in and the manufactured products that go out. Thus you will see that the Merrimack Valley is one of the greatest manufacturing sections in the United States.

I am informed by the gas company of Lawrence that it costs them \$1.15 more per ton for coal than it does the gas companies of Salem and Lynn. The Lawrence Gas Co. uses 36,000 tons annually. Now, the total amount of coal used in Lawrence and Lowell is in excess of 1,000,000 tons, which would be a saving on that commodity of at least 75 cents per ton and perhaps \$1; that would mean a saving annually on one commodity from \$750,000 to \$1,000,000, and that does not take into consideration the other cities and towns on the river. If \$750,000 to \$1,000,000 can be saved on coal alone the saving on cotton, wool, iron, lumber, hides, and other commodities used for manufacturing purposes would be very important. When the Merrimack Valley Waterway Board made their preliminary report, they reported that at least \$1,000,000 a year could be saved; but no consideration was made of the amount of goods that would go out by water, so that it is safe to say that the saving would be nearer two million than one million annually. I understand the United States figures that any scheme of improvement should equal 4 per cent annual saving on the Federal investment. Figuring on a 4 per cent basis, we should ask for \$25,000,000 to \$50,000,000, but such is not our intention. We ask the Federal Government to supply the difference between \$1,000,000 and the cost of the completed work.

The people in this valley are very enthusiastic to have this river open to navigation, feeling assured that they have the best proposition to-day in this country.

When we compare figures it is then that we find out how important this valley is. The raw material and manufactured products going in and out from this valley amount to over \$313,000,000. That is greater than the imports and exports of any city in the Western Hemisphere with the exception of New York and Buenos Aires, and it exceeds the foreign trade of any of the countries of the Western Hemisphere with the exception of the United States, Canada, Brazil, and the Argentine Republic. It is over $7\frac{1}{2}$ per cent of the entire foreign trade of the United States. It is equal to $12\frac{1}{2}$ per cent of the entire foreign trade of the Republic of France; it is equal to 25 per cent of the entire foreign trade of the Russian Empire; and it is equal to 50 per cent of the entire foreign trade of China and Japan; it is nearly \$30,000,000 greater than the foreign trade of Manchester, England, where they have spent \$90,000,000 for canals and docks. It is \$67,000,000 greater than the foreign trade of Glasgow, where over \$50,000,000 have been spent dredging the river. The foreign trade of the United States per capita is in the neighborhood of \$400, but the trade of this valley in raw material and manufactured goods is over \$1,000 per capita.

I write you these facts because I consider that on former occasions this comparison has never been made, but it is necessary to do so in order for you to base any just decision on the needs of the people of this valley for water transportation.

The statistics collected by this office show a total of about 100,000 tons of freight annually, including coal, received and shipped at Haverhill, the head of existing navigation on the river. While the statistics submitted by the waterway board indicate a large consumption of coal and of raw and manufactured products, it is problematical how much of this freight would be carried by water if facilities were provided. Many manufacturers are back from the line of the river and already equipped for receiving and shipping by rail, and it is to be feared that while undoubtedly many would derive great benefit, the actual water-borne commerce after the improvement has been made would be disappointing in not showing a profitable investment.

21. The savings on coal receipts by water are increased because the season of navigation, which would probably be reduced by ice and freshet conditions to six or seven months, occupies the part of the year when coal is the cheapest. This is offset by the fact that if all coal be received by water it must be delivered at a monthly rate twice as great as that involved in all-rail delivery, and one-half of it must be stored in warehouses or piles sufficient to hold a six-months' supply. The water facilities while in use must therefore be capable of daily delivering twice as much coal as the railroads need provide for, and the cost of storage and the interest on money invested in half an annual supply of coal will be lost if all coal comes by water. Then too, the cotton crop becomes available for shipment in the fall and the probability is that the river would be closed by ice before a supply for the cotton mills of Lawrence and Lowell could be obtained. Another point that militates against shipment of cotton partly by rail and partly by water is that generally through bills of lading can not be obtained on such shipments. Most of the cotton for shipment by water must first be shipped by rail to tidewater and then transferred to boat. As a rule this can not be done on through bills of lading and the producer or dealer has to wait until arrival of cotton at destination to collect the price. In shipping through by rail, on the contrary, the producer or dealer can collect the cash at once on his bill of lading. With the scarcity of funds that usually attends the movement of crops, this is an important consideration.

22. The Merrimack Valley Waterway Board states in its report that in the opinion of manufacturers there would be a saving of 50 cents to \$1 per ton on coal over rail rates if adequate facilities for water transportation were provided, in addition to the saving in transportation charges on general merchandise, raw material, and manufactured products.

Experience has shown that the principal saving to be anticipated on inland waterway improvements is in the movement of coal, ore, and other coarse, heavy freight in bulk. Although a saving is often estimated on general merchandise and other package freight, it is difficult, except perhaps between large cities comparatively near each other, to compel package freight to follow water routes.

23.

Summary of estimates.

Channel from Black Rocks Beacon to Ward Hill, with dam at Lions Mouth -----	\$2, 750, 000
State estimate (Merrimack Valley Waterway Board) for channel from Ward Hill to Hunts Falls, Lowell, exclusive of land damages and bridge removal, new bridge, alterations, etc., as indicated above-----	\$5, 443, 600
Less cost of dam above Mitchells Falls and lock at Ward Hill, rendered unnecessary by dam at Lions Mouth, estimated -----	1, 117, 000
	4. 326, 600
Total -----	7, 076, 600

24. In addition to the estimate for the necessary channel there would be a very large indeterminate expenditure by State and local interests for suitable terminals at Haverhill, Lawrence, and Lowell, and for flowage rights. It is not improbable that the cost of the project, including the great changes to be made along the river fronts of the several cities to provide suitable terminal and transfer facilities and to adapt the existing factories and power plants to the full and adequate utilization of the water transportation proposed, with all other expenses incident to the improvement, would total upward of \$10,000,000. Any improvement undertaken by the United States should be conditioned on the State or local municipalities obtaining all flowage rights without expense to the United States, and providing and operating under public control adequate terminal and transfer facilities, and guaranteeing the operation, free of tolls forever, of the portion improved by the State.

Considering the improvement on an investment basis and assuming a total cost of the entire improvement of \$10,000,000, the annual interest charge at 4 per cent would be \$400,000, to which should be added at least \$100,000 for maintenance, amounting to a total of \$500,000, with no sinking-fund charges, to be saved annually before the improvement would be placed on a paying basis.

25. Using the most favorable figures reported in the Merrimack Valley Waterway Board's report, the total inward and outward commerce of Lowell, Lawrence, and Haverhill might possibly total 5,000,000 tons annually. It would be necessary to assume that one-half of it would go by water, and that there would be a net average saving of 20 cents per ton on these 2,500,000 tons, a total saving of \$500,000, to equal the estimated annual cost of the improvement.

26. It is claimed that although the saving, if the improvement were made, might not be reflected in the statistics of water-borne commerce, it would nevertheless exist because it would compel a reduction in rail rates. The regulation of such rates under existing law is under control of another branch of the Federal Government and the soundness of the doctrine of making waterway improvements with Federal public funds to compel reduction in rail rates has been seriously questioned. It does not seem sound economically.

27. I have made several inspections of the river and have conferred with those interested. The Merrimack Valley Waterway Board has made a comprehensive study of the scheme for improving the upper river, has recommended the adoption of the project and

an appropriation of \$1,000,000 toward carrying it into effect. The appropriation of this amount has been made by the Commonwealth conditioned upon approval of the project and making of an appropriation by Congress toward the work. An earnest effort has been made on the part of the State authorities and the people of the Merrimack Valley to obtain the improvement, but after careful consideration, I am forced to the conclusion that the Merrimack River, from Lowell to the sea, or in any part of this section of the river, is not worthy of further improvement by the United States at this time because of the large cost involved and the great uncertainty that benefits commensurate with so large an expenditure would be realized. Further, the cost of a tidal channel to Ward Hill is prohibitive and I consider the construction of a dam in the river to obtain the required depth as attended with serious objections both as to the pondage of sewage and as to the effect of such a dam on the existing improvement of the river at the mouth by tidal scour.

28. Other than as reported above, there are no questions of terminal facilities, water power, or other related subjects which could be coordinated with the suggested improvement in such manner as to render the work advisable in the interests of commerce and navigation. The proposed dam would develop a mean head of water of about 8 feet, ranging from $4\frac{1}{2}$ feet at high tide to $11\frac{1}{2}$ feet at low tide, but because of the uncertainty as to the quantity of water available during the low-water season in summer time, when the entire flow of the river is shut off by the Lawrence dam on Saturdays and Sundays, it is doubtful if there would be sufficient water to fully cover lockage, leakage in a movable dam, and the necessary power for operating the locks.

W. E. CRAIGHILL,
Lieutenant Colonel, Corps of Engineers.

[First indorsement.]

THE DIVISION ENGINEER, NORTHEAST DIVISION,
New York City, December 1, 1914.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. Forwarded.

2. In his report the district engineer officer has thoroughly treated the matter, and after careful and conscientious investigation has come to the conclusion that the investment is so large as to make it apparent that the total cost of the improvement proper plus terminal improvements, land damages, bridge repairs, etc., would largely exceed the sum which the savings on cost of transportation would return to the people in a reasonable time. I am very familiar with this case and have given it careful thought ever since the preliminary examination was first placed in my charge. I have conferred with the district officer, have studied the maps and data in his office, and am forced to concur in his view that the benefits to be derived do not justify the investment on the part of the State and of the United States of the large sum of \$10,000,000.

FREDERIC V. ABBOT,
Colonel, Corps of Engineers.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
December 14, 1914.

To the DISTRICT ENGINEER OFFICER,
Boston, Mass.:

1. It has been represented to the Chief of Engineers that parties interested in the improvement of the Merrimack River have substantial additional facts tending to prove the advisability of improving the Merrimack River; and in order that you may give consideration to such additional data your report is returned to you herewith.

2. Interested parties should be given such time as they desire to submit additional data, provided that the resubmission of the report should be delayed not longer than November 1, 1915.

3. Attention is invited to the accompanying copy of letter¹ to Hon. John J. Rogers, dated December 10, 1914.

By command of the Chief of Engineers:

W. KELLY,
Major, Corps of Engineers.

(To be returned through the Division Engineer, Northeast Division.)

[Third indorsement.]

UNITED STATES ENGINEER OFFICE,
Boston, Mass., October 22, 1915.

To the CHIEF OF ENGINEERS, United States Army.

(Through the division engineer.)

1. Pursuant to the foregoing instructions, a public hearing, of which a stenographic report is herewith,¹ was held at city hall, Lawrence, Mass., April 15, 1915, at which full opportunity was given everyone interested to be heard, and since that time further conferences have been held at this office with Congressman Rogers, Mr. Sutherland, and others. At the hearing additional evidence¹ was presented and 16 exhibits¹ filed by persons representing Haverhill, Lawrence, and Lowell interests.

2. My principal reasons for reporting adversely on this improvement were, briefly:

- (a) That it would not be a paying investment;
- (b) That the effect of a dam at Lions Mouth on the existing improvement of the river at the mouth by tidal scour would be detrimental;
- (c) That pondage in the proposed dam of the sewage of cities along the banks would be objectionable.

3. The most important consideration, to my mind, is the question of whether or not the improvement would be a paying investment for the United States to make for the benefit of our national commerce, and much additional evidence on this point was introduced at the hearing. Some of the exhibits presented minimize the importance of the effect of the dam on tidal scour and on the pondage of sewage, but I see no reason for changing my views on these points, as set forth in my report, and the present discussion will therefore be confined principally to the question of to what extent the river would be used for navigation, and what saving in freight rates could reasonably be expected.

¹ Not printed.

4. Particular attention is invited to the very interesting brief by Congressman Rogers covering an exhaustive report upon the probable saving that might be expected on the coal shipments if water competition were provided. He figures that a saving of perhaps 42 cents per ton on coal to Lowell and possibly a total saving of \$575,000 on all coal used in Haverhill, Lawrence, and Lowell might be effected. Attention is also invited to the report¹ of Mr. S. F. Sherman, secretary-manager of the Lawrence Chamber of Commerce, who figures a possible annual saving in freight charges on Lawrence commerce alone of \$638,780 and on five articles of commerce for the three cities of Haverhill, Lawrence, and Lowell a total of \$1,610,202. These two exhibits are submitted by advocates of the project. On the other hand, attention is invited to the three papers,¹ dated January 12, March 24, and April 15, 1915, submitted by Mr. Hiram F. Mills, engineer of the proprietors of the locks and canals on Merrimack River. Mr. Mills, in these papers, negatives the advisability of the proposed improvement and estimates the saving on coal at 23 cents per ton, or possibly \$230,000 on the 1,000,000 tons, which is a rough estimate of the amount of coal consumed in the locality. Thus we have the expected saving per ton on coal ranging from 23 cents, as estimated by Mr. Mills, up through 42 cents, estimated by Mr. Rogers, to 95 cents, as estimated by Mr. Sherman.

5. The figure of 6 cents per ton for towage from the mouth of the Merrimack to Lowell and return, based on a 1,500-ton barge, appears to me too low. In towing vessels up the tributaries of Boston Harbor there is an additional charge of 1 cent per ton for steamers and barges and 3 cents per ton for sailing vessels for each bridge passed through. This is verified by the following quotation from Congressman Rogers:

Boston & Maine R. R. G. F. A. I. C. C., No. 8383 (filed Dec. 1, 1908, effective Jan. 4, 1909, and still in force), provides rate of 85 cents per 2,240 pounds on coal from Boston (Mystic Wharf or Mystic River), Mass., to Lowell, Mass., and tariff provides that rate will include bridge charges or expenses for going through one bridge, viz., 1 cent per gross ton in steamers or barges and 3 cents per gross ton in sailing vessels.

This being the case, it does not seem to me reasonable to suppose that conditions would be materially different on Merrimack River, so far as bridge charges are concerned, and a vessel would have to pass through 13 bridges and 2 locks in ascending the river to Lowell.

6. In my foregoing report on the survey it was stated that—

It is not improbable that the cost of the project, including the great changes to be made along the river fronts of the several cities to provide suitable terminal and transfer facilities and to adapt the existing factories and power plants to the full and adequate utilization of the water transportation proposed, with all other expenses incident to the improvement, would total upward of \$10,000,000.

The proponents of the project have questioned this figure and have indicated that they thought it too large and have stated that land damages would not amount to more than a quarter of a million dollars, etc.; but in this connection it should be borne in mind that all the mills at Lawrence and Lowell have been built up with the idea of using water for power (except at low-water periods, when auxiliary steam plants are used) and without any provision or, perhaps, thought of the river ever being made navigable for seagoing vessels.

¹ Not printed.

Great changes must necessarily be made to adapt these mills to the receipt of their coal and raw materials and shipment of their products by water. At Lawrence the mills that are located on the river present a practically solid wall along the water front, with their machinery on the river side and their power plants and coal pockets on the land side, arranged for direct deliveries by rail. Such changes, if they were made at all, could be made only at great expense. Terminal and transfer facilities suitable for traffic based on a project whose actual cost would be over \$7,000,000 would alone cost a very large sum. Further, it should also be noted that the Merrimack Valley Waterway Board carried the project only to a point below the foot of Hunts Falls—more than 2 miles by any existing road from the Lowell manufacturing plants and on the opposite side of the river. While it must be conceded that there is a large number of proponents of the project in the three cities of Haverhill, Lawrence, and Lowell, it should be noted that of these large users of coal, the great manufacturing interests of Lawrence and Lowell, whose consumption of raw materials and production of finished products are included in the statistics of the proponents and relied upon by them in justifying the proposed improvement, only three or four representatives of mills have favored the improvement, and none of the others has appeared or expressed any interest in it.

7. I think Mr. Mills in his letter¹ of April 15, 1915, expresses the attitude of the mill owners toward the project. He states:

I have talked with representatives of all of the larger manufactories of Lowell, who are working under an aggregate capital of \$20,000,000 and are paying an aggregate tax equivalent to more than one-fifth of the total tax received by the city, and find they all regard the conclusions reached by Col. Craighill, as presented in his report of November 10, 1914, to the Chief Engineer of the United States Army, as wise and just and have no request to make for their modification.

The lack of interest of the mill owners, however, may be accounted for by the facts in statement of Hon. Butler Ames, of Lowell, viz:

When I was in Congress I tried to increase the railroad facilities between Lowell and Boston, and every mill organization was opposed to it. As near as I could determine, the opposition arose from the fact that the large stockholders in the mills were also stockholders in the railroads.

8. Mr. John A. Murphy, of Lowell, states:

While the present plan calls for terminals at Hunts Falls, the question of the further extension of the channel would only be a matter of engineering and a question of comparing the cost with a system of railway connections.

This idea has also been expressed by others of Lowell. Hunts Falls is a rocky stretch of the river which formerly formed a pool at Lowell. Some years ago the power company cut a channel through the falls which has lowered the level of this pool and increased the head of water power about 3 feet. When it is also considered that to reach Lowell by cutting through this ledge or by another flight of locks would involve great expense and probably interference with the water powers at Lowell, I am inclined to think that the total approximate figure of \$10,000,000 is too small.

9. It should also be borne in mind that the provision in the river and harbor act of March 4, 1915, for an examination of Merrimack

¹ Not printed.

River from Lowell, Mass., to Manchester, N. H., a distance of over 30 miles, indicates a further great expenditure to carry navigation up into the pool of the Pawtucket Dam at Lowell. This pool extends $17\frac{3}{4}$ miles up to Cromwells Falls, thence through the falls and rapids above Nashua to Manchester, a rise of about 33 feet, and the Government in reality would be entering upon a project of great final cost when it undertakes the extension of navigation above tidewater at Haverhill.

10. It is a well-established fact that railroads make rates to meet water competition, and in railroad tariffs the following note frequently appears in connection with rail rates to seaport destinations:

Rates made to meet water competition and will not apply to intermediate points.

Mayor Kane, of Lawrence, in his statement at the hearing, said:

The United Shoe Machinery Co. was located in Lawrence; that is, the companies from which that organization was formed, the Stanley Manufacturing Co. and the McKay Heeler, were here in Lawrence, producing shoe machinery. When the larger company was formed, they immediately went where they got waterfront facilities. And so it comes about that the most desirable form of industries that were in Lawrence have gone out to get what we are seeking to get here to-day.

The United Shoe Machinery Co. is located at Beverly, and the State of Massachusetts and city of Beverly, at an expense of about \$80,000, provided a channel 9 feet deep at mean low water, or 18 feet at mean high water, in Bass River to the Shoe Machinery Co. plant, and mainly for its benefit, but as a matter of fact the company has never used the channel, although it has been located there for more than 10 years. At a hearing before me at Beverly on March 31, 1914, a representative of the United Shoe Machinery Co. made the following statement:

We haven't used that channel; of course they have the small boats there of our employees, but the company hasn't used the channel yet; but we do bring in there a large amount of supplies, in round numbers 15,000 tons of coal a year, 75 carloads of lumber, 70 carloads of coke, 30 cars of sand. All those supplies have come so far by rail, because our contracts call for delivery that way, and partially because we have bought our coal of local dealers rather than to go right to the mines.

And this is to my mind practically what would happen if Haverhill, Lawrence, and Lowell had the facilities they seek for waterborne commerce. The fact that the facilities exist serves the purpose of obtaining more favorable freight rates, but the commerce anticipated on the river would probably never materialize. I do not doubt that the improvement of Merrimack River would result in a sufficient reduction in the railroad rates to offset whatever saving might be made by water shipments, which is in reality all that is desired by the proponents of the project.

11. The Interstate Commerce Commission in its decision of July 30, 1915, No. 4914, in the matter of rates, practices, rules, and regulations governing the transportation of anthracite coal, radically cut the rail rates on anthracite coal from the mines, which cuts amount in some cases to the saving which could be effected between water and rail rates to certain points of shipment. While it may not have an important bearing on the present case, it illustrates the point that a large investment in waterway improvement may be

entirely wasted when by the stroke of a pen an adjustment is accomplished in rail rates that may have the effect of changing the method of transportation from water to rail.

12. I therefore am forced to conclude after further careful study that the benefits to be expected are so uncertain, and the physical difficulties, and consequently the cost, are so great that the improvement should not be undertaken by the United States.

W. E. CRAIGHILL,
Colonel, Corps of Engineers.

[Fourth indorsement.]

THE DIVISION ENGINEER, NORTHEAST DIVISION,
New York City, November 8, 1915.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

Forwarded.

1. In his report of November 10, 1914, Col. Craighill has based his discussion largely on an estimate of \$10,000,000 as the gross cost of the improvements and appurtenant works. From the point of view of political economy this may be justifiable, but gross cost is perhaps not equitable when more than half is to be paid by local authorities, who should be trusted to decide as to their own expenditures, because they know better than a Government officer the indirect benefits they will derive.

2. In the same report Col. Craighill estimates the cost of the 18-foot channel from Black Rocks Beacon to Ward Hill with dam at Lions Mouth at \$2,750,000. The State's estimate from Ward Hill to Hunts Falls, exclusive of land damages, bridge removals, new bridge, alterations, etc., less the cost of a dam above Mitchells Falls, rendered unnecessary by the dam Col. Craighill proposes at Lions Mouth, is \$4,326,600, a total of \$7,076,600.

3. In my preliminary examination report very careful thought was given to the legal aspects of the water-power situation, and the conclusion was reached that the United States could wisely proceed, if the cost was not too great, to give 18 feet of water up to the foot of the part of the river where canalization begins, but that above that point the State should undertake the work in order to coordinate to the best advantage the power and navigation features of the case, as the power developments have been made by the official agent of the State, the proprietors of the locks and canals on Merrimack River.

4. In my report the point delimiting State and Federal work was at Ward Hill. In the project of Col. Craighill his dam raises the river at Lions Mouth to 12.71, a height which the State report asserts to be possible without injury to the water power at Lawrence; but as the State canal leaves the river at Ward Hill, the delimiting point between State work and United States work remains unchanged. The cost to the State, however, will be reduced from its own estimate of \$5,543,600 by \$1,117,000 the cost of their proposed dam at Mitchells Falls and their lock at Ward Hill to raise the river and canal to the level 12.71. I believe that if any project be adopted, Col. Craighill's project is wise, equitable, and well considered. His pool level is no higher than that proposed by the State for their pool above Mitchells Falls. They state officially, on the basis of their survey, that that

will not injure the Lawrence water power. The contribution of the United States would in that case be about 39 per cent of the total, not including the items omitted in the State estimate as given in paragraph 2 above. These items, in Col. Craighill's opinion, not based on known figures, will aggregate nearly \$3,000,000.

5. I believe that for the reasons given in my preliminary report the United States should keep hands off of the part of the river above Ward Hill. If Col. Craighill's original figures are correct, and in paragraph 8 he now states he believes the \$10,000,000 total estimate to be too small, the United States part of the work on my recommended division of costs would be not far from $27\frac{1}{2}$ per cent of the total. If the State and other locally interested parties will agree to such a division of costs I hardly see how an unfavorable report on the United States part of the work can be justified; but I greatly doubt whether such a division would be accepted by them. The report¹ of the Merrimack Valley Waterway Board (Massachusetts House Document 2169) contains the following conclusions:

(a) That the Merrimac River should be improved and opened to navigation by providing a channel 18 feet deep at mean low water extending from the sea to Ward Hill, about 1 mile above Haverhill, and by providing a depth of 18 feet by means of a channel and by building canals and locks from Ward Hill to Hunts Falls at Lowell.

(b) That the Federal Government carry into effect a project providing for a channel 18 feet deep at mean low water, from the sea to Ward Hill, about 1 mile above Haverhill, and that the Commonwealth of Massachusetts cooperate with the Federal Government in carrying such a project into effect, the basis, form, and method of cooperation to be agreed upon after all facts and data have been obtained.

(c) That the Commonwealth of Massachusetts adopt and carry into effect the project prepared by the Merrimac Valley Waterway Board for the improvement of the Merrimac River from Ward Hill, about 1 mile above Haverhill, to Hunts Falls, at Lowell, substantially as outlined in this report, namely, by excavating a channel of adequate width and 18 feet deep in the river and by building locks and canals to provide a depth of 18 feet, and that the Federal Government cooperate with the Commonwealth of Massachusetts in carrying such project into effect, and that the basis, form, and method of cooperation in respect to the State's project be agreed upon at the same time as agreed upon in respect to the Federal Government's project for improvement of the river as far as Ward Hill.

(d) That work under projects for improvement of the Merrimac River from the sea to Hunts Falls at Lowell be carried on progressively upstream, and in such manner and at such times as will insure the earliest possible completion of the projected channel as far as Lowell.

* * * * *

(f) That the legislature memorialize Congress to take early and favorable action looking to the improvement of the Merrimac River and its opening to navigation from the sea to Lowell, and urging that appropriations be made to carry out the necessary work in cooperation with the Commonwealth of Massachusetts.

(g) That an appropriation of \$1,000,000 be made by the legislature for the purpose of improving the Merrimac River, and as evidence of agreement by the Commonwealth to a policy of cooperation with the Federal Government with respect thereto, the expenditure of this appropriation to be conditioned upon the passage by Congress of appropriations for the same purpose.

Conclusion (c) definitely states that the United States should cooperate in bearing the cost of work above Ward Hill. Col. Craighill's project does do this to a degree, by his dam at Lions Mouth; but even this leaves the heaviest part of the burden on the State or

¹ Printed in part at the end of this document (see p. 143).

local interests, if my suggested point of junction with the State work be adopted, even though this would eliminate State cooperation below Ward Hill, suggested in (b) above.

6. In the discussion by Congressman Roberts, by former Congressman Ames, and by others, much stress is laid on the possible reduction of railroad rates that might result from the work. They also argue that railroad rates will increase if the river be left unimproved. Personally, I do not believe that this part of the discussion should be given too great weight in reaching our conclusions. I realize that the consideration is one of the deepest significance to those who have to pay the railroad rates, but the United States now has provided for the control of rates quite largely by the Interstate Commerce Commission, and not improbably their powers may be increased in the future, so as to give them direct control. This is better than an indirect control by expensive river improvement, which simply affords that commission an opportunity to permit reduction of rates to points enjoying water competition. Mr. Walter L. Fisher, former Secretary of the Interior of the United States, in a paper published in the *Journal of Political Economy*, volume 23, pages 652, 653, and 654, writes as follows:

* * * Many calculations by the opponents of waterway improvement are based upon the improper inclusion of items which do not belong in the accounts. These calculations, however, should serve the useful purpose of compelling us to test every new waterway project in the light of past experience, and to adopt correct principles of determining upon the wisdom of future expenditures. All of us—public officials and private citizens, taxpayers and tax spenders, shippers and consumers of freight—should have the keenest desire to learn why our past expenditures upon waterway development are now producing so little return, so that we may intelligently determine to what extent, in what manner, and upon what projects future expenditures for waterways should be made.

Is it cheaper to transport freight by water than it is by rail? If it is cheaper upon the Great Lakes, is it also cheaper upon the great rivers? If it is cheaper upon the great rivers, is it also cheaper upon canalized rivers and upon artificial canals? Why is it cheaper in one case and not in another? Can some kinds of freight be carried more cheaply or more advantageously upon all or some of these different kinds of waterways than the same kinds of freight can be carried by rail? What are the kinds of freight and the kinds of waterways which permit this to be done, and what are the reasons for the different results? How far are these results due to natural and persistent causes inherent in the conditions of economic and commercial development? How far are they the result of unsound methods, of obstacles that can and should be removed? How far can and should destructive competition give way to helpful cooperation between these two great agencies of transportation? Why should this country tolerate anything but effective cooperation between them? If water transportation between two points is cheaper than rail, why should we permit a railroad, by any tactics or actions whatsoever, to deprive these points of the benefits of the cheaper means of transportation? If water transportation between two points is not cheaper than rail, why should we spend the public moneys to create or to promote water transportation between these points? With either agency of transportation the inclusive cost of the service comes in one way or another from the pockets of the public. Why should we spend money upon either unless the particular expenditure is justified by convincing evidence of the benefits it will produce? We certainly should not permit a railroad to increase its general rates if it is cutting some of its rates below a fair margin of profit in order to stifle water competition, if it is buying boats in order to prevent them from running, if it is running boats at a loss in order to destroy independent shipping, if it is holding undeveloped water terminals in order to prevent their use, if it is refusing to cooperate in the transshipment of freight and the making of reasonable joint rates. And is it

not equally clear that we should not expend public moneys upon any waterways upon which freight can not be carried as advantageously as it could be carried upon railroads if the same amount of public money were expended upon each? Is it not in each instance a question of which agency, water or rail, is, upon the whole, the cheapest and most efficient, considering in each instance the amount of money to be invested in the creation of the waterway and the railway, respectively, as well as the relative costs of equipment and operation?

7. Following the above reasoning, which I believe is sound, the question reduces itself to a simple one: Will the river afford such additional facilities for transportation of freight as to justify the investment in its improvement of the large sum of \$10,000,000, of which \$2,750,000 comes from the General Treasury and \$7,250,000 from the State, cities, and the people on Merrimack River? As the local interests derive indirect benefits not enjoyed by the United States at large, they should be allowed to decide as to the advisability of their spending their \$7,250,000 or more, if it prove necessary, and the United States must decide whether its quota, \$2,750,000, is justified by the benefits the people of the United States at large will secure. Four per cent on this sum is \$110,000. Even Mr. Mills estimates a possible saving in freights of \$230,000 per annum, and he is confessedly an opponent of the project. Other estimates run much higher. Between the two limits probably the truth is to be found. If the total cost to the United States is limited to \$2,750,000, I believe the General Government is perhaps justified in cooperating in a project for 18 feet up to Hunts Falls; but if the State would modify its project so as to carry 18 feet into the Lowell Pool, the question would hardly be open to doubt. Congress has already ordered an examination of the Merrimack River with a view to carrying navigation from Lowell to Manchester, N. H. Before any definite action is taken by Congress on the United States part of the project to Lowell, I believe reliable data as to the improvement up to Manchester should be available for consideration by its committees. In other words, I advise considering the entire Merrimack River up to Manchester as one indivisible subject. If it be determined that navigation can not be provided above Lowell, a terminus at Hunts Falls may afford sufficient justification to the United States to do the work up to Ward Hill if the State work provides the 18 feet from that point to Hunts Falls, the whole project lying entirely within the territorial limits of the State of Massachusetts. If Congress is to extend navigation to Manchester, N. H., however, access must be had to Lowell Pool. For the reasons given above, the work needed to afford such access should be executed by the State of Massachusetts under its own officers, and not by the United States directly; but the interstate character of the river might have a bearing on the quota which the United States should bear, and possibly a cash contribution to the State of Massachusetts might be equitable. The matter of this combination of State and Federal work is one involving many difficulties, and should receive very careful consideration, before the United States commits itself to any project for either of the improvements in question.

FREDERIC V. ABBOT,
Colonel, Corps of Engineers.

[For report of the Board of Engineers for Rivers and Harbors, see p. 5.]

PRELIMINARY EXAMINATION OF MERRIMACK RIVER, LOWELL TO MANCHESTER.

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
Boston, Mass., March 25, 1916.

From: The District Engineer Officer.

To: The Chief of Engineers, United States Army
(Through the Division Engineer).

Subject: Preliminary examination of Merrimack River from Lowell, Mass., to Manchester, N. H.

1. In compliance with instructions contained in letter dated March 15, 1915, and with provisions of the river and harbor act approved March 4, 1915, the following report is submitted on the preliminary examination of Merrimack River, from Lowell, Mass., to Manchester, N. H. Under the river and harbor act of July 25, 1912, an examination and survey of Merrimack River from its mouth to Lowell have been made and report on the preliminary examination was submitted under date of March 29, 1913, and on the survey under dates of November 10, 1914, and October 22, 1915. The survey report considered a channel to be obtained by dredging and by locks and dams, 18 feet deep at mean low water, extending from the sea to Hunts Falls, about 2 miles below Lowell, the work to be done in part by the United States and in part by the State of Massachusetts. Interests in Manchester now desire the extension of this proposed 18-foot channel from Hunts Falls at Lowell to Manchester, N. H. The distance from the mouth of the river to Hunts Falls is about 38 miles, and from there to Manchester about 35 miles. The report on the improvement of the river to Hunts Falls, which was estimated to cost about \$10,000,000, was unfavorable. The improvement herein proposed to Manchester is, of course, entirely dependent on the improvement of the river from the mouth to Hunts Falls, and to this extent the two should be considered together.

2. *Locality.*—Merrimack River has its extreme headwaters in northern New Hampshire. The main river is formed by the confluence at Franklin, N. H., of the Pemigewasset and Winnepesaukee Rivers, whose drainage areas cover 1,520 square miles. Near Concord, N. H., it receives the Contoocook River, and at Nashua, the Nashua River; their drainage areas being respectively 766 and 516 square miles. The river flows in a generally southerly and easterly direction, and from Franklin, N. H., to its mouth near Newburyport, Mass., is about 110 miles in length, of which about 60 miles lie in New Hampshire and about 50 miles in Massachusetts. The two cities above Lowell that the proposed improvement would reach directly are Nashua, N. H., a city of about 26,000 population, and Manchester, the largest city in New Hampshire, with a population of over 70,000, and an assessed valuation in 1912 of over \$68,000,000. The river as a whole from Hunts Falls to Manchester is a rocky stream consisting of a series of pools and falls, not navigated except by a few small boats in the pool of the Pawtucket Dam at Lowell.

3. *Previous reports.*—

Section covered and date.	Congressional documents.				Annual Report of Chief of Engineers.		Favorable or unfavorable.
	House or Senate.	No.	Congress.	Session.	Year.	Page.	
Merrimack River from Lawrence, Mass., to Manchester, N. H., 1881.	Senate Ex.	45	Forty-seventh.	First....	1882	532	No definite recommendation as to worthiness or unworthiness appears to have been made. Unfavorable.
Merrimack River from Lowell, Mass., to old New Hampshire State line, 1897.	House...	242	Fifty-fifth...	Second..	1898	884	

4. *Work previously done.*—The section of the river under consideration has never been improved by the United States. Before the building of the railways, the river had been improved by private enterprise and is reported to have been navigated by canal boats (about 1806–1835) with about 3 feet draft, from Boston via the old Middlesex Canal to Lowell; thence to Manchester and above to Concord, N. H., by means of a series of locks and dams, the remains of some of which still exist.

5. *Navigable extent, controlling depth, and fluctuation of water surface.*—Between Lowell and Manchester the river is navigated at present only by a few motor boats in the pool of the Pawtucket Dam at Lowell, where the controlling depth is about 8 feet.

The river is subject to violent freshets in the spring. At the Pawtucket Dam in Lowell the flood of April, 1852, necessitated the use of a guard gate across the upper lock. At that flood the river was 14 feet 1 inch above the top of the Pawtucket Dam. Between January, 1852, and May, 1901, there were 10 freshets during which the height of water exceeded 10 feet above the top of this dam. The dates and heights reported are as follows:

April 22, 1852, 14 feet 1 inch above top of dam.
 March 20, 1859, 10 feet 8 inches above top of dam.
 April 20, 1862, 10 feet 9½ inches above top of dam.
 March 14, 1865, 10 feet 9 inches above top of dam.
 October 6, 1869, 10 feet 3¾ inches above top of dam.
 April 21, 1870, 13 feet 1¾ inches above top of dam.
 December 12, 1878, 10 feet 11 inches above top of dam.
 April 16, 1895, 11 feet 5½ inches above top of dam.
 March 3, 1896, 12 feet 9⅝ inches above top of dam.
 April 8, 1901, 10 feet 3 inches above top of dam.

In paragraph 4 of the report of March 29, 1913, on preliminary examination of Merrimack River from the sea to Lowell there appears an extended discussion of the fluctuation of the water surface of the river, including a table showing the monthly mean gauge readings at the lower locks gauge at Lawrence, extending over a period of 63 years. Similar data for the section of the river between Lowell and Manchester are not available, but the volume of water as given for Lawrence would, of course, be decreased progressively upstream

by the flow of Concord and Nashua Rivers and other feeders of this upper section. Statistics of the flow of the river at Lawrence, furnished by the Essex Co., show a maximum average flow at Lawrence between 1880 and 1914 for the month of April of 16,822 cubic feet per second, and a minimum average flow of less than 3,000 feet per second during the same period for the months of July, August, and September. The flow at Lowell is estimated to be about 90 per cent of that at Lawrence. In the preliminary examination report just referred to it was stated (par. 4) :

In the nontidal part of the river (which is all of the river above Mitchells Falls, about 3 miles above Haverhill) the effect of the mills (referring to the mills at Lawrence and Lowell) is a maximum at the time of low water, for then they use the pools above the dams for pondage. While the mills are shut down they store water for use during the hours when they are in operation, thus reducing to nothing the discharge immediately below the dams. In discussing this pondage, Mr. C. W. Thom, of Haverhill, said at the hearing on October 4, 1912 :

"I don't want to say anything against Lowell and Lawrence. I suppose they are looking after themselves and must protect themselves. But I did not know there was any such law that allowed them to absolutely stop the flow of this river. I suppose they have so little water that they have to. But for the last three or four years, I have been motoring up here for the last few years, and I have seen the river absolutely cut in two at Lowell and Lawrence; not one drop. The flow absolutely stopped. Dams and canals are all right if they will let it go around and over and give us a flow down there. That would be all right. But if it was not for the protection of the tide we would have nothing there. Every week we would have absolutely nothing but mud flats, and we have not much more than that there now. It is something awful there, the stench of the mud."

Two photographs¹ are inclosed showing the general character of the river bed over a stretch of the river extending about 200 to 300 feet below the Pawtucket Dam at Lowell. The photograph looking upstream toward the dam was taken June 29, 1915, and shows the condition when the entire flow of the river is being used for power purposes. Under these conditions any water taken for lockage would be a direct reduction of the amount available for power purposes. The other photograph was taken from immediately below the dam, looking downstream over about the same stretch of the river. On the right in this photograph is seen the wall of the northern power canal of the Locks & Canals Co. leading from Pawtucket Dam.

Merrimack River is navigated now to Haverhill, Mass., through the channel dredged by the United States 7 feet deep at mean low water. Above Haverhill there is no commercial navigation. One or two miles above Haverhill are the Hazeltine Rapids and Mitchells Falls. At Lawrence, where the river is closed by the large power dam of the Essex Co., a pool is formed extending about 8 miles upstream, making the river navigable to Hunts Falls for motor boats drawing 2 to 3 feet. At Lowell the river is again closed by the large power dam, known as Pawtucket Dam, of the proprietors of the Locks & Canals on Merrimack River. A small canal around the dam through the city of Lowell affords connection with the river below for small boats, but it is rarely if ever used. Between Lowell and the mouth of Nashua River, in Nashua, 13½ miles, it appears from previous surveys that the depth of channel is not less than 8 feet, obstructed by bowlders and ledges and by the remains of an

¹ Not printed.

old dam across the river at Tyngs Island, through which is a gap 25 feet wide carrying over 10 feet of water. The pool of the Lowell mill pond ends about 4 miles above the mouth of Nashua River. From there to Manchester, a distance of about 13 miles, the channel becomes much shoaler and more rocky and is obstructed by series of falls and rapids, in which there is a rise of about 31 feet to overcome.

6. *Character and extent of improvement desired.*—I inspected the section of the river under consideration on September 3, 1915, and again on October 1, 1915, when I met at Manchester Ex-Congressman Eugene E. Reed, at whose instance the provision of the examination was inserted in the river and harbor act, and others interested in the proposed improvement. The improvement desired is the extension of the 18-foot channel considered in the survey reports of November 10, 1914, and October 22, 1915 (referred to in paragraph 1 above), from Hunts Falls, below Lowell, to Manchester, N. H. I requested all of those present at the meeting to furnish statistics of commerce and other figures to show the benefits to be expected in case the improvement were made, and the amount and character of tonnage of material that would be carried in the river and the saving in freight rates which would be effected. The responses received appear in paragraph 10, under the heading of “Commerce, freight rates, etc.”

7. *Head room and available width of channel at bridges.*—At Lowell and between Lowell and Nashua the river is crossed by six bridges, all without draw openings, viz:

Name.	Clear height.		Clear width of channel.
	Mean low water.	Mean high water.	
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
Centralville Bridge.....	22.7	4.6	150
Aiken Street Bridge.....	27.3	8.4	146.5
Moody Street Bridge.....	27.6	1.2	174.5
			173
Pawtucket Street Bridge.....	32.1	6.4	150
			140
Tyngs Island (Vesper Country Club).....	21.5	7.8	550
Tyngsborough (highway).....	17.6	1.8	131

There are two bridges in Nashua, a railroad bridge at Goffs Falls, and several bridges at Manchester, concerning which there are no details available as to dimensions.

8. *Unusual difficulties of navigation.*—The cities along Merrimack River are engaged principally in manufacturing, and the stream from Lawrence up is used for water-power purposes and not for navigation except, as previously stated, by a few motor boats in the pool of the Lowell Dam. The river is paralleled by the Boston & Maine Railroad, and the manufacturing plants are designed for receiving and shipping their freight by rail. The problem of obtaining navigation must therefore be considered with reference to its effect upon existing water-powers, and to the feasibility of adapting present manufacturing plants to receive and ship freight by water.

To extend 18-foot navigation from Hunts Falls to Manchester, the project may be divided into two parts: first, to obtain a channel

through or around Hunts Falls and the rocky valley immediately below Pawtucket Dam at Lowell into the pool above the dam, a total lift of about 47.5 feet; and second, to secure a channel from the dam through the pool and the falls in the river up to Manchester.

Two methods of passing Hunts Falls and Pawtucket Dam have been considered:

The first method is to follow the bed of the river from the end of the channel proposed by the Merrimack Valley Waterway Board in 1914 at Hunts Falls, and carry a channel through Hunts Falls to the deep pool in the bed of the river at Lowell; and from this pool by means of locks and a canal to enter the pool above Pawtucket Dam. Access to the first pool from below Hunts Falls may be obtained by either of two methods: First, to carry a channel 200 feet wide at the level of the pool formed by the Lawrence Dam through Hunts Falls; second, by a lock at the foot of Hunts Falls with a lift of about 5 feet (at low-water stage), and a canal from this lock along the north bank into the first pool.

The first of these methods, through Hunts Falls, is considered the better, and comparison is in its favor on actual cost of structures, without considering the cost of compensating dredging of the river, which will be necessary with the canal on the north bank proposed by the second method; also, lowering the bed of the river through Hunts Falls to the pool above incidentally increases the head of water-power about 5 feet at low-water stage.

From this deep pool to above Pawtucket Dam three alternative routes present themselves at first glance.

The first of these is to pass through the deep pool to a point above the mouth of Beaver Brook, which enters Merrimack River from the north, and thence by means of locks enter a canal which would extend along the north bank of the river for about three-fourths of a mile into Pawtucket Dam.

The second is to pass through the same deep pool to a point a short distance above the Aiken Street Bridge, and there enter by means of locks a canal which would extend along the south bank of the river for about three-fourths of a mile, merging into the canal supplying water to the mills in the northerly section of Lowell.

The third would be by departing from the Merrimack River bed at the lower end of the deep pool, excavating a channel in the rocky bed of the Concord River for about one-fourth mile to the lower dam of the Pawtucket Canal, and thence through the two dams in that canal, follow the route of Pawtucket Canal a distance of about $1\frac{5}{8}$ miles into the upper pool of the Merrimack about one-fourth mile above the Pawtucket Dam.

Considering these three methods in reverse order, the route through the Pawtucket Canal requires heavy rock excavation in the bed of the Concord River, and passing through the city of Lowell is crossed by six highway and three railroad bridges. The canal at present is presumably only of sufficient width and depth to carry the water supply necessary for operation of the mills; and to adapt it to the purpose of passing vessels without interference with the water-power supply would practically involve the additional construction of a canal of sufficient capacity for navigation purposes $1\frac{5}{8}$ miles in length through the city, where property damage would necessarily be

very great; for which reason it appears that this route may be dismissed without further consideration.

Considering the second route, incorporating the power canal with the ship canal would probably result in no economy of construction; and as it is of practically the same length as the first and is on the south side of the river, where land values are higher, it appears to present the disadvantage of possible interference with existing water-power routes and no advantage of lesser cost.

The first described route, therefore, from the deep pool to above Pawtucket Dam is considered the best.

The second method of passing Hunts Falls and Pawtucket Dam is by the creation of a summit lake in the valley of Beaver Brook by a dam just above Dracut, and by means of locks and canal leave the river below Hunts Falls, lock up to this summit lake, and thence descend into the pool of the Pawtucket Dam by canal and lock through the valley of Flagg Meadow Brook. On consideration this was found impracticable, because of lack of sufficient water for lockage.

To obtain a channel 200 feet wide and 18 feet deep at low-water stages of the river from Pawtucket Dam to Manchester will require a dam and lock with lift of about 14.5 feet just above the mouth of Nashua River, a second dam and lock with lift of about 16.5 feet at the foot of Little Cohas Falls, and a large amount of excavation in the pools formed by the three dams. The length of these pools will be about 13.5 miles for that above Pawtucket Dam, about 12 miles for that above mouth of Nashua River, and about 5 miles to the foot of Merrills Falls for that at Little Cohas Falls. The foot of Merrills Falls is in the lower part of the city of Manchester, and the pool can not be further raised without flooding the tail races of the water powers, nor can navigation be further extended at the proposed pool level without excessively costly excavation in the rocky river bed.

9. *Water power, land reclamation, etc.*—Some land reclamation would be incident to the disposal of the material to be excavated under the project, but as land is plentiful and cheap along the banks, no particular values would be created by the addition of such land as would be reclaimed in this way.

The question of water-power development may enter into consideration of the project. It is assumed that the water at Manchester may be held at the level of the foot of Merrills Falls without material interference with the water power created by the Amoskeag Dam at Manchester. On this basis the total rise of the river from the pool of the Pawtucket Dam would be about 31 feet in a distance of about the same number of miles. In this distance the river experiences six distinct lifts, known as Cromwells, Moores, Little Cohas, Goffs, Short, and Griffins Falls. To overcome this rise, the two dams described in the preceding paragraph would be necessary, both to avoid excessive flowage damages and heavy cutting in the bed of the river. The water power at Manchester for eight or nine months of the year is stated to be 12,000 to 15,000 horsepower by day and 2,500 horsepower by night, reduced one-third to one-half during the remaining months of the year. For the purposes of consideration here it will be assumed that it averages 7,500 horsepower, which is obtained through a fall of about 52 feet. This volume of water, slightly increased, passes down river through the sites of the two navigation

dams, and if it could be utilized at these two dams it would produce about 2,300 horsepower at each, taking it in direct proportion to the fall. The Little Cohas Dam, however, would be so near the water-power development of Amoskeag Dam that a movable dam would be necessary, so the water power could not be utilized. A fixed dam at Nashua River may be practicable, but although this statement is made without investigation or data to show the influence of floods on the power at so low a head as 14.5 feet, I think it may be said without uncertainty that power development in connection with this dam would be of but small value as compared to the cost of the project.

10. *Commerce, freight rates, etc.*—As is clear from the foregoing, there is no water-borne commerce at present on the stretch of the river under consideration herein. At the meeting on October 1, 1915, at Manchester with those interested in the improvement I requested them to furnish statistics of the commerce of Nashua and Manchester and data to show the benefits anticipated if the improvement were made, together with estimates of the amount and character of tonnage that would be carried by river if water transportation were available and the saving in freight rates which might be expected. Two requests for such data were made upon the mayor of Nashua, but no reply has been received. Repeated requests upon those interested in the project at Manchester were made, and submission of the report has been suspended for some time with the expectation that satisfactory information would be forthcoming, but the only report submitted in compliance with my request is contained in the following letter of the president of the Manchester Publicity Association, inclosing a copy of letter of Mr. Albert L. Clough, of Manchester:

MANCHESTER PUBLICITY ASSOCIATION,
Manchester, N. H., January 25, 1916.

DEAR COLONEL CRAIGHILL: I have finally been able to get some data regarding the bulk tonnage coming into Manchester.

This matter was turned over to a gentleman here in Manchester to get this information, and he has gone into the matter very carefully, with the following results:

In order that you may get this information just as it comes from him, I am sending you a copy of his letter of January 15 giving you this information.

While he has not gone into the matter quite as exhaustively as what I had hoped he would—that is, from a standpoint of showing what benefits a navigable waterway to Manchester would have on surrounding territory adjacent to Manchester—still, I think the figures he has compiled will give you a basis on which to draw your conclusions, and I most sincerely hope that after giving these figures your consideration you will feel the matter is of sufficient importance to find out in every possible way yourself not only the unfavorable conditions but all of the favorable conditions that would warrant you in making a favorable report.

Regretting exceedingly that there has been so much delay in giving you these figures and assuring you that if there is anything of vital importance that has been omitted I can supply you with, I should be very glad indeed to have you advise me, I remain,

Sincerely, yours,

A. B. JENKS.

Col. W. E. CRAIGHILL,
Corps of Engineers.

JANUARY 15, 1916.

DEAR SIR: As you will remember, I was asked to ascertain the approximate tonnage of bulk freight shipped annually into and out of this city which could be handled by canal if the Merrimack deep-waterway project was carried out.

In order to gather the required data, the attached letter¹ was sent out on November 12, 1915, to all manufacturers, coal dealers, lumber dealers, public-service companies, and users of bulk materials of a nature which could be handled by water. Very few replies were received to this letter and to "follow-up" letters sent out somewhat later, and most of the information was obtained rather laboriously by urgent appeal to the various shippers over the telephone.

I conclude that coal and building materials are the main classes of freight which could be carried over the proposed canal, and that practically all the shipments would be inward, there being but little outgoing freight which could be handled by water. Most of our lumber and nearly all of the stone used here come from the north.

In my opinion, about 265,000 tons of coal comes into this city per year and perhaps about 175,000 tons of materials classifiable as building materials. Of raw materials for manufacturers perhaps about 90,000 tons are annually received, making a total for these three classes of about 530,000 tons annually. If to this total be added 10 per cent to take account of materials not covered in the estimate, the total annual tonnage may be taken as 563,000.

These estimates are of a decidedly approximate character, but they are very much better than mere guesses, and I think are fairly near the truth.

Yours, very truly,

ALBERT L. CLOUGH.

Mr. A. B. JENKS, *President,*

Manchester Publicity Association and Chamber of Commerce,

Manchester, N. H.

Most of the coal for Manchester is now received by water to Portsmouth, thence about 40 miles by direct rail connection over the Portsmouth branch of the Boston & Maine Railroad. The freight rate on coal is about \$1 per gross ton. The normal water rate on coal from Hampton Roads to Portsmouth is but 5 cents more than the Boston rate and 15 cents to 20 cents less than the rate to Newburyport at the mouth of Merrimack River. Manchester and vicinity thus receives practically all its water-borne coal from Portsmouth as the distributing point. Nashua probably receives its water-borne coal from both Portsmouth and Salem as distributing points, and the rates are not materially different from those for Manchester. It will therefore be seen that to start with at Newburyport the rate is 20 cents more than at Portsmouth. (The rate by sea to Salem is the same as the Boston rate.) The largest single user of coal in Manchester is the Amoskeag Manufacturing Co., which has perhaps the largest textile mills in the world. Its coal consumption is about 150,000 tons per annum, which is delivered directly by rail at its large power plant now located about three-fourths of a mile above the point where navigation would end. For this company to bring coal by water would involve either rehandling at Manchester to reach its power plant, or else moving its power plant downstream to the head of navigation. The use of either method would probably offset any saving in freight rates that might be expected. It must be borne in mind that the all-water freight rate for coal from Hampton Roads, or any of the Atlantic coal-distributing points directly to points on Merrimack River is quite problematical when it is considered that it would be necessary to add to the voyage by sea to Newburyport about 70 miles of river navigation to Manchester through five or six flights of locks and many drawbridges over a river which would be closed to navigation for a large part of the year and perhaps not easy of navigation at any time. The freight tonnage as given above by the Manchester Publicity Association,

¹ Not printed.

representing as it presumably does the total freights of that class received at Manchester, manifestly would not all come by water if navigation were provided.

Existing plants are adapted to receive their shipments by rail and it can not fairly be expected that expensive alterations necessary to receive such freight by water would be quickly adopted unless the advantage were very substantial. Assuming, however, that 400,000 tons would be received by water, which I believe is much more than can reasonably be anticipated for both Nashua and Manchester, and a saving of 25 cents per ton would be made, which I also believe to be more than could be reasonably expected, and capitalizing this saving on a 4 per cent basis, such saving would justify an expenditure of \$2,500,000, which is but a fraction of what the project would cost, disregarding entirely the expense of maintenance and operation, which would be large.

11. *Terminal facilities*.—As the section of the river under consideration is not navigable for commercial vessels there are no existing water terminals and no offers of cooperation by State or local authorities to provide suitable terminals in case the river were made navigable have been received. As previously stated, the manufacturing plants and all industries throughout the Merrimack Valley have been laid out without reference to the possibility of the river being made navigable and a very large expenditure would be necessary to provide suitable terminals and to adapt existing plants to the receipt and shipment of freight by water. Sufficient data to determine the location and nature of such terminals are not available, and in view of the conclusions reached as to the worthiness of the project, are probably unnecessary for the purposes of this report.

12. *Worthiness*.—After careful consideration I report that, in my opinion, Merrimack River from Lowell, Mass., to Manchester, N. H., is not worthy of any improvement by the United States under present conditions for the reason that the benefits to be expected would not be commensurate with the cost involved. This opinion is rendered without regard to the adverse reports submitted by me under dates of November 10, 1914, and October 22, 1915, on the improvement of the river from the sea to Lowell, but I should be forced to the same conclusions, for the same reasons, if an 18-foot channel from the sea to Lowell already existed.

W. E. CRAIGHILL,
Colonel, Corps of Engineers.

[First indorsement.]

OFFICE OF DIVISION ENGINEER, NORTHEAST DIVISION,
New York City, March 31, 1916.

To the Chief of Engineers, concurring in the views of the district engineer officer.

FREDERIC V. ABBOT,
Colonel, Corps of Engineers.

[For report of Board of Engineers for Rivers and Harbors, see p. 8.]

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, August 25, 1916.

From: The Chief of Engineers, United States Army.

To: The District Engineer Officer, United States Engineer Office,
Boston, Mass.

Subject: Preliminary examination and survey of Merrimack River,
Mass.

1. The Chief of Engineers has under consideration the reports on preliminary examination and survey of Merrimack River, Mass., and he would like to have additional information on certain points that do not seem to be adequately covered in these reports.

2. In reviewing the report of preliminary examination, the division engineer expressed the opinion that the project should include the deepening of the channel across the bar at the mouth of the river, and that the studies to be made should cover this point. The Board of Engineers also recommended that the survey to be made by the district officer should include studies for a channel over the bar at the entrance to the river of suitable depth to accommodate a draft of 17 feet at mean low water. It was the expectation that the report of survey would discuss conditions on the bar and give an estimate for such work as might be considered necessary to permit 17-foot boats to cross the bar at low water in stormy weather.

3. The district officer apparently overlooked this feature in making the report of survey, the situation at the mouth being disposed of by a statement, after describing recent changes in that vicinity, that this portion of the improvement might well be left to await the effect of the recent jetty extension, while the other works are being built, and that should the jetty improvement prove insufficient in its final effect, resort may be had to dredging the bar, which was authorized by the act of June 25, 1910, as part of the project for Newburyport Harbor under which project suitable action may be taken to accomplish the required depth. The existing project, however, contemplates a depth of only 17 feet on the bar. The views of the district officer are requested as to the increase in depth that should be provided over the bar on account of wave action in order to accommodate boats of the draft that can use the proposed 18-foot channel inside the bar, together with a statement of the work considered necessary to give the additional depth and its estimated cost.

4. A statement is also desired of the amount of water that would be consumed in lockage if the traffic attains the volume anticipated by local interests, and an approximate estimate of the loss to water-power interests due to this use of the water.

5. The depth of the 18 feet proposed for this improvement appears somewhat inadequate for an important traffic of sea-going vessels, the tendency being to increase the size of barges in coastwise trade. Information is desired as to the probability of there remaining in operation in ocean traffic for many years to come sufficient number of barges not exceeding 17 feet in draft to accommodate the large volume of traffic anticipated by local interests in this case.

By command of the Chief of Engineers.

W. KELLY,
Major, Corps of Engineers.

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Boston, Mass., October 26, 1916.

To the CHIEF OF ENGINEERS, United States Army:

1. Merrimack River is tidal up to the foot of Mitchells Upper Falls, and the tidal prism computed between mean low and mean high water is about 1,090,000,000 cubic feet. A dam located at Lions Mouth will cut off about two-thirds the length of the tidal section of the river and about 377,000,000 cubic feet, or about 34 per cent of the tidal prism. The tidal prism of the river consists in part of river discharge, which varies widely from time to time. The annual average flow of fresh water from the river at the Lawrence Dam is about 6,705 cubic feet per second, and the accumulation of this discharge in the tidal prism during flood tide is about 140,805,000 cubic feet. The ebb of the tidal prism is augmented by the river flow during the ebb period, amounting to about 158,103,900 cubic feet, making the preponderance of ebb over flood flow at the mouth of the river 298,908,900 cubic feet. This preponderance of ebb flow will not be affected by the introduction of a dam in the tidal basin and will still be available to carry on the process of scour in the river channel and over the bar at the mouth.

At the mouth of the river the deep gorge between the north end of Plum Island on the south side of the river and Salisbury Beach Point on the north side has been a feature of all surveys since that of 1880 and has not varied greatly in area of its discharge cross section, which was about 21,000 square feet, to mean ocean level in 1880, and about 27,000 square feet in 1915, a mean of 24,000 square feet. The area of discharge cross section at mean ocean level in 1915 was about 24,000 feet between the outer ends of the parallel arms of the jetties.

These cross sections are the result of current velocities created by the passage of the tidal prism at heads produced by the tidal rise and fall of the ocean, and it appears that a reduction of 34 per cent in tidal prism will result in a very material reduction of the natural gorge cross section and also will render inefficient the artificially maintained discharge cross section between the parallel arms of the present jetties, with a corresponding loss in the depth of water now maintained. To accommodate boats of the maximum draft that can use the proposed 18-foot river channel while crossing the bar in periods of rough weather, increased depth in the channel over the bar must be provided. This increased depth is 5 feet in the new project for Broad Sound Channel, Boston Harbor, in a general channel depth of 35 feet. In the shoaler depth of the proposed Merrimack River channel the seas on the bar will run higher under equal conditions of weather and an allowance of perhaps 7 feet, or increase to 25 feet at mean low water for the bar channel may fairly be made.

To make the jetties conform to the reduced tidal prism caused by the introduction of a dam will require radical reduction in the area of the discharge section between them and possibly the application of controlling works at the gorge in the form of a training wall. The following is an estimate of the cost of the work if this form of improvement were attempted:

For relocating one jetty arm to contract the discharge cross section between the jetties-----	\$240, 000
For possibly necessary control of the discharge cross section at the gorge:	
Training wall extending southeasterly from Salisbury Beach Point-----	\$32, 500
Protection of shore at north end of Plum Island-----	32, 500
	65, 000
Total-----	305, 000

I do not consider, however, that this method of improvement would be advisable and do not recommend it. I believe the only effectual method to keep a channel of 25-foot depth at mean low water, which is, perhaps, the least depth that should be provided if it is to be expected that vessels of 17-foot draft should be able to enter at all conditions of weather and tide, is by dredging. The locality is very exposed and there is no harbor where vessels could lie to await suitable conditions nearer than Portsmouth on the north and Gloucester on the south. While the navigation season on the upper river would be limited to seven months of the year, navigation is open to Newburyport the year round and dredging in maintenance of the channel over the bar would be necessary periodically throughout the year. For maintaining a channel of 25-foot depth over the bar by dredging only, would require a seagoing suction dredge of the smaller type throughout the year; one like the *General G. G. Meade*, of the Grand Rapids, Mich., district (166 feet long, 38 feet wide, 19 feet deep) would be suitable. Such a dredge would cost now about \$250,000, which should be added to the cost of the project. The annual cost of maintenance of the project would also be increased by \$80,000, made up as follows:

Four per cent interest on \$250,000-----	\$10, 000
Annual cost of operations of dredge-----	70, 000
	80, 000
Total-----	80, 000

2. Any discussion as to the amount of water that would be consumed in lockage if the traffic attains the volume anticipated by local interests must be based on assumption throughout and consequently is little better than guesswork. All commerce to Lowell will pass through the lock at Lawrence, and in all probability a large part of that to Lawrence as well, because of the better opportunity to land and distribute materials afforded upon the shores of the pool above the dam.

I will assume that about 50 per cent of the Lawrence commerce would pass the lock. On page 7 of Exhibit 9 accompanying stenographic report¹ of hearing at Lawrence on April 15, 1915, Mr. John H. Murphy indicates the expectation of 1,000,000 tons of commerce to Lowell, and in Exhibit 3, page 2, Mr. S. F. Sherman estimates 1,106,510 tons of freight received and shipped at Lawrence. Assume, then, from these two statements that the total commerce that would pass the lock at Lawrence annually would be 1,500,000 tons. The average coal barge of 17-foot draft, loaded, carries about 1,500 tons. It will be assumed that the coal will be carried in barges of this tonnage, under tow, and as the balance of the commerce would be carried in vessels of various sizes, an average of 500 tons is assumed.

¹ Not printed.

The coal is indicated in Congressman Rogers's statement (p. 24 of stenographic report¹ of hearing of Apr. 15, 1915) to be 400,000 tons to Lowell, and to Lawrence 540,000 tons, and assuming that one-half the latter amount would pass up into the pool of the Lawrence Dam, would make a total of 670,000 tons passing through the lock at Lawrence. Carried in 1,500-ton barges it would require 447 trips up, and as these barges are not suited for general commerce there would be 447 return trips down, light. The balance of the commerce (1,500,000 minus 670,000 tons), 830,000 tons, would be carried in general cargo carriers that might be assumed to carry cargo in going out as well as coming in. On this basis the number of lockages would be $\frac{830,000}{500} = 1,660$. It is therefore assumed that the commerce as anticipated by the proponents would require 447 lockages up, loaded, and 447 down, light, of 1,500-ton barges with towboat, and 1,660 lockages of a 500-ton vessel, 830 up and 830 down, all loaded. The lock as designed by the Merrimack Valley Waterways Board is 360 feet long, 45 feet wide, and the depth at maximum upper pool level is approximately 32 feet, making 518,400 cubic feet contents. It is subdivided into two smaller sections, one 120 feet long and one 240 feet long; the cubic contents of the larger section being 345,600 feet. The 1,500-ton barges with towboat will require use of the large lock; the 500-ton vessels will be accommodated in the 240-foot section of the lock. The displacement of a 1,500-ton barge with towboat will be about 90,000 cubic feet, loaded, and about 39,000 cubic feet, light. The displacement of a 500-ton vessel, including towboat or own power, will be about 30,000 cubic feet.

The small number of lockages per day of the anticipated traffic makes it improbable that economy can be practiced often by favorable combination of upward and downward lockages, and it will be assumed that each passage will require the water necessary for a single lockage.

The water that will be required for lockages determined on the above basis is as follows:

For coal traffic:	Cubic feet.
447 trips up, loaded ($447 \times 518,400$, contents of large lock) --	231, 724, 800
447 trips down, light ($447 \times [518,400 - 39,000]$) -----	214, 291, 800
	446, 016, 600
For balance of commerce:	
830 trips up, loaded ($830 \times 345,600$, contents of large section of lock) -----	286, 848, 000
830 trips down, loaded ($830 \times [345,600 - 30,000]$) -----	261, 948, 000
	994, 812, 600
Total water required for lockage of commerce-----	
During a large part of the navigation season small pleasure boats will pass the dam. A boat lock is provided for their accommodation 60 feet long, 10 feet wide, 32 feet lift—19,200 cubic feet. Allowing an average of 8 passages per day throughout the season will give 1,712 lockages, which will require about-----	32, 870, 400
Total water required for lockage purposes-----	1, 027, 683, 000

The navigation season will extend through about seven months, from May 1 to November 30. This is 214 days total, and the average flow of the river in second-feet that will be required to supply water for lockages will be:

¹ Not printed.

Second feet.

$$\left(\frac{1,027,683,000}{214 \times 24 \times 60 \times 60} \right) = 55.5$$

A large quantity of water in the aggregate will be lost in leakage of valves and gates of the lock; allow for this loss----- 29.5

Making a total draft on the river because of the lock----- 85.0

MINIMUM RIVER FLOW REQUIRED FOR FULL POWER OF THE ESSEX CO.

From information in letter to this office from Mr. Richard A. Hale, engineer of the Essex Co., this minimum quantity is deduced, as follows:

	Cubic feet.	Cubic feet.
5,000 second-feet for 9 hours 45 minutes-----	175,500,000	
2,000 second-feet for 14 hours 15 minutes-----	102,600,000	
	278,100,000	
For 5 days of week -----		1,390,500,000
5,000 second-feet for 5 hours on Saturday-----	90,000,000	
2,000 second-feet for 19 hours on Saturday-----	136,800,000	
	226,800,000	
For 1 day (Saturday)-----		226,800,000
2,000 second-feet for 12 hours on Sunday (86,400,000 cubic feet for 1 day)-----		86,400,000
Total quantity of water required for water power for 7 days -----		1,703,700,000

Average river flow necessary— $\frac{1,653,700,000}{7 \times 24 \times 60 \times 60} = 2,817$ second-feet.

It appears, then, that during periods when the weekly average flow of the river equals the Essex Co. power requirements of 2,817 second-feet, plus the 85 second-feet required for lockages, or 2,902 second feet, there will be no direct interference with the water power at Lawrence.

Study of the records of weekly average flow for a period of 35 years, 1880 to 1914, maintained by the Essex Co. at Lawrence, shows that during the navigation season of 7 months, May to November, inclusive, the weekly average fell below 2,902 second-feet during 23 weeks in 1899 and 1914, 22 weeks in 1908 and 1909, 21 weeks in 1884 and 1910, and in decreasing periods to but 1 week in 1902.

Eighty-five second-feet of water at the fall of 30 feet at Lawrence dam will make 232 horsepower as the maximum loss of power used in lockages, which at \$30 per horsepower per year will be \$6,960 a year, the cost to replace by steam power. Reducing this loss to the maximum period of 23 weeks of deficient river flow gives a probable loss of \$3,078.46.

It thus appears that the maximum direct loss to the Essex Co. for water taken for the lock at Lawrence, computed on a liberal basis for quantity of water required and a maximum dry year, will be about \$3,000.

Because of the greatly varying flow of the river during the summer months the periods of interference with the water power will vary widely between the maximum and nothing. It appears, however, that provision must be made to meet the maximum loss, as represented by the above figures.

3. To aid in the solution of the question asked in paragraph 5, page 77, letters were addressed to 16 coal shippers, ship-building con-

cerns, ship brokers, and others, inquiring as to the probable tendencies in future in regard to draft of vessels engaged in coastwise traffic. Replies¹ were received from fourteen of those to whom inquiries were sent. Attention is invited to the original letters¹ which are inclosed, but for convenience the following brief extracts are given, indicating the general tenor of the replies:

Abstract of replies to letters asking whether there will be remaining in operation in ocean traffic in years to come sufficient number of barges not exceeding 17 feet in draft to accommodate the large volume of traffic necessary to justify costly improvements.

Company and date of letter.	Reply.	Reply considered favorable.
Wm. Cramp & Sons Ship & Engine Building Co., Aug. 31, 1916.	For the coastwise service there will always be a large number of barges and light-draft steamers of 17 to 20 feet.	No.
Williams & Peters, Sept. 1, 1916.	While tendency on Atlantic seaboard and Great Lakes is for increased size of vessels, believe there will be a sufficient number of barges in service to take care of this tonnage, even if necessary for coal companies owning docks to build them themselves.	Yes.
Fore River Shipbuilding Corporation, Sept. 1, 1916.	Development of our rivers and harbors will probably not be such as to permit of utilization of only large deep-draft barges. So far as there being a large number of barges still in service that will use 17-foot channels, seems that this is surely guaranteed by Erie Canal traffic.	Yes.
Lehigh Valley R. R. Co., Sept. 1, 1916.	In all of our trade to eastern ports we find that a barge of about 1,600 tons capacity or 16 to 17 feet draft, is the barge best suited to the needs of our customers. This clearly shows the necessity for barges of light draft as well as for those of deep draft. Where there is much commerce in and out of any port it would seem that they would require more than 17 feet of water, as the traffic is constantly growing and the depth of other vessels than those particularly specified is increasing.	No.
C. W. Chadwick & Co., Sept. 6, 1916.	Of opinion that will be increasing number of barges both under and over 17-foot draft.	No.
Standard Transportation Co., Sept. 5, 1916.	Tendency is to increase draft of vessels. In barge transportation towing must be done by seagoing vessels, which rarely draw less than 17 feet.	No.
The Texas Co., Sept. 5, 1916.	Building of small vessels with comparatively light draft for commercial purposes is practically abandoned, although may be used in some special trades, but as a class they will disappear and be supplemented by vessels requiring 25 to 30 feet of water. Channel 17 or 18 feet is deeper than is necessary for lighterage facilities but not sufficient for seagoing vessels.	No.
Berwind-White Coal Mining Co., Sept. 7, 1916.	Unwise to undertake to dredge certain North Atlantic coast and river harbor ports based on depth of only 18 feet at mean low water as tendency is to enlarge size of vessels and contemplated dredging should be based on depth of at least 26 feet at mean low water.	No.
New York Shipbuilding Co., Sept. 6, 1916.	Doubts whether barges in use along the coast will increase in number or size. Tonnage, especially coal, will be carried in steam vessels between well-established points where there is sufficient depth to accommodate vessels with cargoes up to 10,000 tons.	No.
New York, Ontario & Western Ry. Co., Sept. 26, 1916.	Has disposed of their deep-draft barges because they are not suitable for their trade. Does not think time will ever come when a boat drawing from 15 to 17 feet will not be a most suitable and popular boat in coal trade.	Yes.
Coastwise Transportation Co., Sept. 28, 1916.	Thinks no barges will be built of draft of 24 to 26 feet. Most barges of this draft are old ships cut down. Later barges being built will have draft of 17 to 22 feet. Steamers with draft of 20 to 28 feet are fast taking place of barges and sailing vessels.	No.
Susquehanna Coal Co., Oct. 2, 1916.	Will always be as many, if not more, barges of 17-foot draft in anthracite coal trade, but doubtful in bituminous trade whether, in a very few years, there will be any barges of draft less than 26 to 28 feet.	No.
Consolidation Coal Co., Oct. 6, 1916.	Although most economical way to handle coal is in large steamers with draft of 26 to 28 feet, barges drawing 16 to 18 feet will still be required, but companies running steamers are endeavoring to drive them off the sea. Eighteen-foot channels should be provided everywhere in New England unless expense too great; poor economy to provide more than this except at large ports.	No.
Philadelphia & Reading Transportation Line, Oct. 17, 1916.	Is of opinion that demand for barges not exceeding 17 to 18 feet draft loaded will warrant perpetuation of this type of vessel and that there will remain in operation in the coastwise trade in years to come a sufficient number of such barges to warrant contemplated improvements based on a depth of 18 feet at mean low water. (This is classed as unfavorable as it should be noted that in the 3d paragraph of his letter (p. 89) the writer remarks that 18 feet draft at mean low water means 26 to 28 feet at high water between Cape Cod and Bangor, Me. In considering his remarks it should be borne in mind that he did not appreciate that the improvement under consideration involved navigation through a pool where only 18 feet depth would be available at all times.)	No.

It is my own opinion that large steam colliers carrying 8,000 to 10,000 tons are fast displacing coal barges. The New England Coal & Coke Co. and the Coastwise Transportation Co. have fleets of this type of vessel and the Darrow-Mann Co. is building five of them, the smallest of which is 9,500 tons carrying capacity. These vessels draw between 25 and 30 feet of water and it is not improbable that the lower rates that could be made by such vessels to ports along the coast, such as Boston, Salem, Portsmouth, and Portland, would largely offset the possible saving if barges of, say, 1,500 tons capacity could navigate directly to Haverhill, Lawrence, and Lowell. The rail freight rate on coal from Boston and Salem (which immediately adjoins Beverly) is about 85 cents per ton to Haverhill, Lawrence, and Lowell. A favorable report is now before Congress for a project of 24-foot depth at mean low water at Beverly, which already has a large and efficient coal-distributing plant, and supplies by steam railroad, street railway, and automobile trucks a large zone in that locality. The colliers of the New England Coal & Coke Co. and Coastwise Transportation Co. even now, with only 18-foot depth of water at mean low water at Beverly, do, with some difficulty, get in there on the top of the tide, and if the 24-foot channel eventually comes to Beverly it is most probable that it will become a very important coal-distributing point, with a much more extended zone of distribution, reaching these Merrimack River cities, as they are now reached from Salem, a distributing point for coal brought in by barges.

It appears to me that the river improvement is going to be at a serious disadvantage, limited, as it will be, to 1,500-ton barges drawing 17 feet of water, in competition with vessels carrying 10,000 tons to deep-water coast ports having efficient and economical distributing plants for reshipping to points not far distant inland. It may be true that the 17-foot barge will be continued in service to some extent to serve special localities, but it is quite possible that the result will be a repetition of the experiences in other instances along the North Atlantic coast, where improvements were made some years ago on the basis of 12 and 14 foot draft barges, which have almost disappeared in coastwise traffic, and the shippers are now forced to use the few lighter draft barges, say 15 or 16 feet, only partially loaded and paying freight on the entire cargo-carrying capacity of the vessel.

(1)

Colonel, Corps of Engineers.

LETTER OF THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING CO.

PHILADELPHIA, PA., August 31, 1916.

SIR: We are in receipt of your favor of the 30th instant in reference to the improvements in rivers and harbors along the North Atlantic coast.

In reply we beg to say that it is our opinion for the coastwise service there will always be a large number of barges and light-draft steamers of about 17 to 20 feet engaged in such traffic.

The modern ocean-going cargo vessels, however, require cargo to accommodate from 24 to 26 feet draft.

Very respectfully,

THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING CO.,
H. W. HAND, *Vice President and General Manager.*

Col. W. E. CRAIGHILL,
Corps of Engineers.

¹The above indorsement was prepared by direction of the district engineer officer, but was not signed by him owing to his illness and subsequent death.

LETTER OF WILLIAMS & PETERS.

NEW YORK CITY, *September 1, 1916.*

DEAR SIR: We beg to acknowledge receipt of your favor of the 30th ultimo, in which you ask if we think there will be a sufficient number of barges not exceeding 17 feet draft to accommodate the large volume of tonnage going to coastwise ports.

While the tendency, both on the Atlantic seaboard and on the Great Lakes, is for increased size of vessels, we believe there will be a sufficient number of barges in service to take care of this tonnage, even if it is necessary for the coal companies owning such docks to build them themselves; they can not afford to have their whole plant put out of commission, or even embarrassed, by such a situation. Freight rates have ruled so low for the past few years that there has been very little inducement for the building of new barges, so that there is an actual scarcity at all Atlantic seaports at the present time.

Yours, truly,

WILLIAMS & PETERS.

Col. W. E. CRAIGHILL,
Corps of Engineers.

LETTER OF FORE RIVER SHIPBUILDING CORPORATION.

QUINCY, MASS., *September 1, 1916.*

SIR: Answering your letter of the 30th ultimo, while I have not given this subject a great deal of study, it seems probable to me that the development of our rivers and harbors will probably not be such as to permit of the utilization of only large deep-draft barges.

For instance, the Erie Canal will, when completed, bring into existence an enormous number of barges of limited draft but with sufficient carrying capacity and seagoing qualities to permit them to operate through Long Island Sound and up the New England coast. These barges are limited to 12-foot draft.

It would seem to me that there will probably be a number of other ports where a depth of 17 to 20 feet could be maintained at comparatively small cost, and where a deeper channel would be prohibitive, that would offer sufficient field for a type of barge intermediate between the Erie Canal barge and the very deep-draft one. While, of course, as harbors deepen and more receiving and shipping points are available the tendency will be wherever practicable to go to even larger barges than the 24 or 26 foot ones that are at the present time quite popular.

So far as there being a large number of barges still in service that will use the 17-foot channels, it seems to me that this is surely guaranteed by the Erie Canal traffic, which I expect to see assume very large proportions.

Very truly, yours,

J. W. POWELL, *President.*

Col. W. E. CRAIGHILL,
Corps of Engineers.

LETTER OF LEHIGH VALLEY RAILROAD CO.

JERSEY CITY, N. J., *September 1, 1916.*

DEAR SIR: I have your favor of the 30th instant and will be glad to answer your inquiry so far as it is possible for me to do so.

While it is true that coal barges are built to very large capacities, those drawing 24 and 26 feet are usually converted vessels and were not built for barges. There is a certain trade that can not be served with large barges. In all of our trade to eastern ports we find that a barge of about 1,600 tons capacity, or 16 to 17 feet draft, is the barge best suited to the needs of our customers. In other words, while they can handle 1,500 to 1,600 tons of coal in one barge, there are a great many yards that can not handle 2,000 tons or more. This clearly shows the necessity for barges of light draft as well as for those of deep draft. Where there is much commerce in and out of any port it would seem that they would require more than 17 feet of water, as the traffic is constantly growing and the depth of other vessels than those particularly specified is increasing.

Yours, truly,

J. M. CHERRY,
Superintendent of Floating Equipment.

Col. W. E. CRAIGHILL, *Corps of Engineers.*

LETTER OF C. W. CHADWICK & CO.

NEW YORK, *September 6, 1916.*

SIR: Yours of the 30th instant, re draft of barges, etc.

In reply beg to state that the writer is of the opinion that barges have come to stay. It is an economical mode of transporting cargoes by water, and the writer is of the opinion that there will be increasing number of barges both 17 feet under and 17 feet and over.

Yours, very truly,

C. W. CHADWICK & Co.

Col. W. E. CRAIGHILL, *Corps of Engineers.*

LETTER OF STANDARD TRANSPORTATION CO.

NEW YORK CITY, *September 5, 1916.*

DEAR SIR: Answering your favor of August 30.

The tendency is to increase the draft of coasting vessels, barges, and steamers, the latter in a great measure superseding the barges in transportation, and all-water transportation naturally tends to the deepest draft for the sake of economy.

Even with barge transportation it should be borne in mind that a seagoing vessel must do the towing, which rarely draws less than 17 feet, indicating this to be the natural limit of improvements for harbors where these vessels are to operate.

How far harbor improvements of 17 feet or greater are justified depends largely upon the local requirements of the river that is under consideration, as, for example, in the port of New York, an otherwise exceptional port for the entry of all classes of vessels, many of our adjacent streams can barely accommodate vessels of limited draft. How far the improvements to these streams are justified would seem to depend largely upon the amount of business.

Along our coast are many ports restricted by the entrance channel.

Yours, truly,

R. C. VEIT.

Col. W. E. CRAIGHILL, *Corps of Engineers.*

LETTER OF THE TEXAS CO.

NEW YORK, *September 5, 1916.*

DEAR SIR: I have for acknowledgment your valued communication of August 30.

It seems to me that the dispositions of shipowners, influenced or perhaps governed by the necessities of the times, are departing from the use of light-draft vessels.

The record of shipbuilding surely indicates the practical abandonment of the building of small vessels with comparatively light draft for commercial purposes. I presume there will always be some special trades in which comparatively small and light-draft vessels will be used, but I am very strongly of the opinion that as ocean-going vessels capable of carrying their full dead-weight, or a draft of 17 or 18 feet, are wrecked or worn out, they will disappear as a class from the ocean and will be supplemented by vessels requiring from 25 to 30 feet of water. I have placed the maximum at 30 feet because, in my opinion, for general trading this will suffice for a number of years, except in special cases, because of such limitations in the ports of the world, including the ports of the United States, and because of the fabulous sums that will be involved in bar and harbor improvements to make vessels of a greater draft entirely serviceable for world-wide or even our own coasting trade.

I think you will find that most of the tonnage now building and in contemplation requires more than 25 feet of water for their full dead-weight carrying capacity, but that all can carry their full cargo on 30 feet of water, or something in between 25 and 30 feet.

If I were called upon to pass on a project for harbor improvement that would involve the dredging of a channel, contemplating the use of vessels drawing when fully loaded 17 or 18 feet, I would report adversely unless it was a very special case.

In my estimation, a 17 or 18 foot channel is deeper than is necessary for lighterage facilities, but is not sufficient for ocean-going vessels; thus, in my opinion, it would be an extravagant channel contemplating the use of lighterage facilities and would be practically a waste of funds contemplating the use of ocean-going vessels.

Yours, very respectfully,

W. A. THOMPSON, Jr.,
Manager, Marine Department.

Col. W. E. CRAIGHILL,
Corps of Engineers.

LETTER OF BERWIND-WHITE COAL-MINING CO.

NEW YORK, *September 7, 1916.*

DEAR SIR: Regarding your letter of August 30, we beg to state that in our opinion it would be unwise for the War Department to undertake to dredge certain North Atlantic coast and river harbor ports based on a depth of only 18 feet at mean low water. For years past the demands for larger ocean-going coast craft have grown, and the tendency is to enlarge the sizes of barges and other vessels, with the corresponding increase in draft. We feel that in order to meet the near future requirements, the contemplated dredging to be done by the department should be based on a depth of at least 26 feet at mean low water. At the present time there are barges and other vessels, recently constructed, drawing 24-26 feet, and the old tonnage when worn out will surely be renewed on the larger scale of tonnage and increased draft.

This is merely an expression of our views, and we will be glad to answer any of your further inquiries in regard to the matter.

Very truly, yours,

JOHN E. BERWIND, *Vice President.*

Col. W. E. CRAIGHILL,
Corps of Engineers.

LETTER OF NEW YORK SHIPBUILDING CO.

CAMDEN, N. J., *September 8, 1916.*

DEAR SIR: We have yours of August 30, concerning the matter of increasing the depth of various rivers and harbors on the North Atlantic Coast, on account of the increased draft of vessels.

We may say that there is naturally an increase in draft and size of all vessels as time goes on. We doubt, however, whether the barges in use along the coast will increase in number or size.

While we have built a considerable number of barges, they have been of a type not exceeding 18 feet in draft, and for a number of years we have not built any barges whatever, but have built a very considerable tonnage of steam vessels, which are engaged in the coastwise coal-carrying trade, and which, of course, have to run between well-established points, where there is sufficient draft of water to accommodate the vessels, carrying cargoes up to possibly 10,000 tons. We are even building one collier of 12,000 tons.

We understand that you wish us to give you our view as to the probable course of vessel construction for coastwise business, and have to say that such business as we have done, or have any prospect of, indicates the probability of more cargo, especially coal being carried in steam vessels between established terminals, and does not point to the same proportion of barge construction as has obtained in the past.

Very truly, yours,

NEW YORK SHIPBUILDING Co.,
H. A. MAGOUN, *Vice President.*

Col. W. E. CRAIGHILL,
Corps of Engineers.

LETTER OF NEW YORK, ONTARIO & WESTERN RAILWAY CO.

WEEHAWKEN, N. J., *September 26, 1916.*

DEAR SIR: Answering your circular letter of August 30.

We have disposed of our deep-draft barges because they are not suitable for our trade, and we do not expect to have any more. The greatest draft of any of our boats at the present time is 19 feet.

I do not think the time will ever come when a boat drawing from 15 to 17 feet will not be a most suitable and popular boat in the coal trade.

Yours, truly,

B. F. HANFIELD,

Shipping Agent and Superintendent of Floating Equipment.

Col. W. E. CRAIGHILL,

Corps of Engineers.

LETTER OF COASTWISE TRANSPORTATION CO.

BOSTON, MASS., *September 28, 1916.*

DEAR SIR: In reply to your letter of August 30 and your letter of later date. I note in your letter that the tendency in the past 15 or 20 years has been to greatly increase the draft and cargo-carrying capacity of coal barges and other similar craft so that there are now 24 and 26 foot barges.

In reply would say I do not think there will be any barges built that will have a draft of 24 to 26 feet of water. Most barges of this draft are old ships cut down. All the later barges being built will have a draft from 17 to 22 feet. Steamers with a draft of 20 to 28 feet are fast taking the place of barges and sailing vessels.

Very respectfully,

COASTWISE TRANSPORTATION Co.,

J. G. CROWLEY,

General Manager and Treasurer.

Col. W. E. CRAIGHILL,

Corps of Engineers.

LETTER OF SUSQUEHANNA COAL CO.

NEW YORK, *October 2, 1916.*

DEAR SIR: Replying to your letter of September 22 regarding draft of barges in the coal trade on the Atlantic coast, would say that so far as the anthracite trade is concerned it is the opinion of the writer that there will always be as many, if not more than at present, barges of 17-foot draft, but in the bituminous trade it is doubtful whether in a very few years there will be any barges having a draft of less than 26 to 28 feet.

Yours, truly,

WM. H. LEWIS,

Superintendent of Construction and Repairs.

Capt. F. B. DOWNING,

Corps of Engineers.

LETTER OF THE CONSOLIDATION COAL CO.

BALTIMORE, MD., *October 6, 1916.*

Col. W. E. CRAIGHILL,

Corps of Engineers.

DEAR SIR: Your communication of August 30, in regard to the depth of water at North Atlantic ports, was referred to me, and I sent it to Mr. R. C. Gillespie, our manager at Boston, with request that he reply to you direct. About this time he was taken ill and shortly afterwards was compelled to go away on a long vacation, which accounts for the failure to reply.

When the proper facilities for rapid loading and unloading can be provided, the economical way to handle coal from Chesapeake Bay ports to New England is in large steamers carrying from seven to eight thousand tons, with

a draft of from 26 to 28 feet. There is, however, a large trade in New England that requires light-draft vessels, where the unloading machinery would **not justify the employment of the large steamer.** This trade has heretofore been taken care of by coal barges drawing from 16 to 18 feet, towed by tug-boats.

Many companies that run fast passenger and freight steamers seem to think that sailing vessels and barges have no right on the ocean. They have worked up public sentiment to a considerable extent, and they are apparently doing everything they can, through governmental restrictions, to drive them off the sea. Unless the Government regulations become too burdensome, however, these coal barges will continue to run for a great many years, and it would therefore seem to be poor economy to provide for a greater depth of water than 18 feet, so far as the coal industry is concerned, at New England ports, except Boston, Portland, and, possibly, Portsmouth and Providence, I think it can be safely said that an 18-foot channel should be provided everywhere in New England, unless the expense is so great as to make it a clearly uneconomical expenditure.

While the above remarks apply only to the coal trade, with which I am familiar, I have every reason to believe they will probably fit the transportation of other commodities as well.

Yours, very truly,

W. L. ANDREWS,
Manager of Transportation.

LETTER OF THE PHILADELPHIA & READING TRANSPORTATION LINE.

PORT RICHMOND, PHILADELPHIA, *October 17, 1916.*

DEAR COLONEL: Following up my letter dated 2d instant, in acknowledgment of your two letters dated August 30 and September 22, on the subject matter of the probable tendencies regarding the draft of seagoing barges in the future, and further in connection therewith, we have to say that the question you raise is rather a complex one, as it is difficult to foresee just what the future has in store for us with respect to requirements as to draft of seagoing barges engaged in the coastwise trade.

Perhaps a retrospect of what we have done in the past and are now doing as regards sea-barge equipment, carrying capacity, and draft loaded would give the basis for the most intelligent reply to your inquiry. We operate at the present moment sixty-six (66) seagoing barges, classified as follows, together with their draft loaded, viz:

Class.	Num-ber.	Draft loaded.
		<i>Ft. in.</i>
A.....	3	15 6
B.....	7	16 0
C.....	15	14 0
D.....	36	17 0
E.....	5	20 0
Building 6, Class D, 17-foot draft	66 6	
Total.....	72	

It will here be noted that of a fleet of 72 vessels, 67 of them, or 93 per cent, are of draft 17 feet and less. The Class D barge, carrying 1,500 tons on a 17-foot draft, is, from our experience, most in demand by the trade and, consequently, more popular than any other type or class of vessels engaged in coast-wise traffic. Barges of a lesser draft than 17 feet and of consequently less-carrying capacity are only in demand for shoal-water points and are unprofitable, as a rule, to operate.

As regards the reference in your letter of August 30 to the tendency in the past 15 or 20 years to greatly increase the draft and cargo-carrying capacity of coal barges, we may say that however this has been with other vessel owners, we have not followed along these lines; we have been operating seagoing barges

for the last 27 years; the greatest draft vessel we now operate is the Class E barge, 3,000 tons carrying capacity on a 20-foot draft. We operate but 5 of this class in a fleet of 72, and it is not likely that we will ever exceed this, as we feel that our Class E barge has about reached the limit in size, capacity, and draft in barge construction.

It would appear to us that an 18-foot draft at mean low water will no doubt be sufficient for barge operation in the future, as that depth at low water means from 26 to 28 or 30 feet at high water between Cape Cod and Bangor, Me. It is possible that the future may develop the necessity for an intermediate barge, carrying 2,000 to 2,500 tons, but the Class D and Class E barge operated by this company will, we think, in all probability become eventually the minimum and maximum cargo-carrying draftloaded vessel, at least by this company.

It is true, as you say in your note of August 30, that there now are barges drawing from 24 to 26 feet of water, but they are not barges that were built for the coastwise carrying trade; they were cut down or reconstructed from square riggers or old steamships; these will pass out in the near future.

In conclusion it is our opinion that the demand for barges not exceeding 17 to 18 feet draft, loaded, and of a carrying capacity of 1,500 tons, or thereabouts, will warrant the perpetuation of this type and class of vessel, and that there will remain in operation in the coastwise trade in the years to come a sufficient number of such barges not exceeding 17 or 18 feet in draft that would warrant the contemplated improvements of rivers and harbors along the North Atlantic coast as proposed, based on a depth of 18 feet at mean low water.

If our views on this subject matter will be of aid to you in the matter you have in hand, we are glad to have been of service.

Very truly, yours,

O. H. HAGERMAN,
Shipping and Freight Agent.

Col. W. E. CRAIGHILL,
Corps of Engineers.

LETTER OF HON. JOHN JACOB ROGERS, M. C.

LOWELL, MASS., *November 14, 1916.*

MY DEAR GEN. BLACK: On September 5, last, at a conference at which were present Congressmen Phelan and Gardner and I, representing the various sections of the valley of the Merrimack River in Massachusetts, you discussed the report of the Board of Engineers for Rivers and Harbors which had in June recommended the improvement of the Merrimack River from Lowell to the sea and which at the time was before you for approval or disapproval. You stated to us that there were several points upon which you wished further information before you reached a final decision. After you had indicated these several points we asked for time in which to collect and present to you evidence bearing upon them, and you granted us until October 15, last. The labor and time involved in the collection of this supplementary material proving more considerable than we had anticipated, we in October obtained an extension until November 15.

We herewith respectfully present the results of our supplementary investigation dealing particularly with the points upon which you desired information.

A.

Attitude of business and industrial interests of Merrimack Valley.

At our conference you referred to the importance of ascertaining accurately the sentiment of our local industries toward this project and stated that unless there was a very definite desire on their part that the river should be developed, you saw no reason why the Federal Government should be called upon to make the large necessary appropriation. Recognizing the importance and propriety of informing you fully on this point, we have taken up the matter with the principal industries of Lowell and Lawrence, which are much the largest cities on the banks of the Merrimack.

Lowell: The Lowell Board of Trade on September 18, last, sent out 48 letters to the larger corporations of Lowell, asking for their opinion. I append a copy of this letter marked "Exhibit A."¹ A summary of our "referendum"

¹ Not printed.

is appended as "Exhibit B."¹ In response to our 48 letters, 39 replies were favorable, 3 were unfavorable, 1 was noncommittal, and 1 declined to answer. Four failed to reply at all; 2 of these 4 are, however, subsidiaries of the American Woolen Co., which, as I shall later show, was already recorded in favor. I append as a part of "Exhibit B" the original replies. It should be said that we sought to reach every large consumer of coal in the city of Lowell entirely without regard to its attitude or supposed attitude toward the project. The scope of our inquiry may be learned from the fact that the replies are from concerns employing some 32,000 persons. We feel that this voluntary indorsement of the Merrimack River project by the overwhelming majority of the large Lowell consumers of coal conclusively establishes the demand, so far as Lowell is concerned, for the development.

As indicating that coal is by no means the only commodity by which the river channel would be utilized, we call your especial attention to the letter of the Consolidated Rendering Co., with two branches in Lowell, and itself a subsidiary of Swift & Co., of Chicago, which intimates that a considerable proportion of its Lowell tonnage of 100,000 tons a year would arrive at and leave Lowell by water if the Merrimack were made navigable. Although for convenience we have emphasized coal transportation, upon which we anticipate an average freight saving of at least 50 cents per ton, we are confident that many other products, such as cotton, cement, and lumber, as well as rendering raw materials and products and other specialized commodities, would make abundant use of the channel if the Merrimack River project were developed. (See footnote 1, at end of letter, p. 95.)

Lawrence: The parties in Lawrence interested in Merrimack River development adopted a somewhat different method of securing the opinion of the large consumers of Lawrence relative to Merrimack River navigation. I append as "Exhibit C"¹ two original petitions, strongly indorsing the navigation channel, signed by the principal industries of the city of Lawrence. Those in favor, as in Lowell, include practically all of the largest and most important corporations of the community. There are, I am told, but two important corporations of Lawrence unrepresented upon the petition.

One of them is the American Woolen Co., whose president, Mr. William M. Wood, could not be seen during the period when the petition was in circulation. However, it may be stated that the American Woolen Co. is in favor of the project, as shown by the fact that at the hearing on the project before the Committee on Rivers and Harbors of the House of Representatives held December 10, 1914, the consulting engineer of the company, Mr. William S. Whitney, appeared and spoke in favor. On page 31 of the official committee report of the hearing Mr. Whitney says:

"I am authorized by the American Woolen Co. to state that they are in favor of this project."

I am informed that the representative of the other company not represented upon the petition is not opposed, although he is not inclined to go so far as to sign a petition in favor.

The showing thus made by Lowell and Lawrence is a remarkable one, considering the obstacles which have confronted those favoring a navigable Merrimack. As the three Congressmen told you verbally, the water power of Lowell and Lawrence is controlled respectively by the proprietors of the locks and canals on Merrimack River (Lowell) and the Essex Co. (Lawrence). The engineer and chief executive officer of both of these companies is Mr. Hiram F. Mills, an eminent engineer. Mr. Mills has been throughout the only outspoken opponent of the project. While we have no wish to question his sincerity, his opposition may readily be explained upon the theory that as agent of the water-power companies he desires no changes made which can even conceivably impair in the slightest degree or even affect existing water-power conditions. We have felt that his opposition might, so far as the broader aspect of the case and general community welfare were concerned, be heavily discounted because of his own peculiar and individual interest in the maintenance of existing water-power conditions. In spite of his undoubted influence in such matters with the mills of Lowell and Lawrence which purchase their water power from the water-power companies of which he is the head, but four of the Lowell companies in the group are noncommittal or opposed, six being affirmatively on record in favor, and but one of the Lawrence group fails to be recorded in favor. The treasurer of one of the four Lowell mills not in favor is president

¹ Not printed.

of the Locks & Canals Co.; the treasurer of a second is treasurer of the Locks & Canals Co. All four are very largely owned and officered by interests not identified with the Merrimack Valley, and I believe that there are but four Lowell men in all on the four directorates.

The showing thus made by the majority of the very corporations making use of the water power of the river proves how baseless is the suggestion that the coming of navigation would adversely affect our great industries of the Merrimack Valley.

We could adduce, if it seemed desirable, an abundance of testimony from the press of the valley and from merchants and individuals of the various cities strongly and even enthusiastically indorsing the project. We assume, from your statement to us, that you are more concerned with the attitude of the large consumers and especially of our great textile manufacturers; we have therefore limited our inquiries as above indicated.

B.

Effect of improvement upon water power.

In our conversation with you and in your letter dated August 25 last to Col. Craighill you indicated that you desired information as to the amount of water consumed in lockage and an approximate estimate as to the loss of water-power interests due to lockage.

In answering this question reference has been made to the records of both the Locks & Canals and the Essex Co., the former being the Lowell water-power company and the latter being the Lawrence water-power company.

It should first be pointed out that there will of course be no loss of water power whatever at Lowell, with the head of navigation located at Hunts Falls, just below the Lowell mills.

In Lawrence there will be a minute loss of power, though, as we shall show, this loss will be rather theoretical than practical. In order to reach a correct conclusion as to the theoretical loss we have consulted the power company engineers for data, and have been able to figure the actual loss of water power and the actual use of water per filling of the locks at the Lawrence Dam.

Assuming that the largest of the locks will be used in accordance with the plans and specifications published in the reports of the investigating engineers we find that each filling of the lock will require the use of 12.8 second-feet of water figured on the working day's flow, the working day being 10 hours. This is the equivalent of 37.6 horsepower at the Lawrence dam. The records of the Essex Co. furnished on page 78 of United States Geological Survey, Water Supply Paper 321, give the daily discharge, in second-feet, of the Merrimack River at Lawrence in the year 1912, which, by the way, should be recorded as a dry year. You will note by consulting these figures that, except for a few Sundays in the summer months, the regular discharge of the river is several thousand second-feet in a day and that the 12.8 second-feet required for filling the lock once is a negligible amount of the flow.

On the 9th of April, 1912, the total discharge was 30,720 second-feet. The proportion of this required to fill the lock once is infinitesimal. Even taking July 13, 1912, when the total discharge in a day was at its minimum of 1,189 second-feet, the filling of the lock still represents an extremely small percentage of the total discharge. The mean second-feet for 1912 was 6,174, and this, we repeat, was a year when dry conditions prevailed.

We believe it is proper to assume, then, that the filling of the main lock at the Lawrence dam once each day entails the use of an amount of water of no serious worth to the water power company or to the mills. It should further be stated that in the months of the year when the river is high enough to permit water to flow over the dam, indicating an unusable surplus for water power purposes, it is not proper to charge the filling of the lock with any use of water power supply whatever, as the water used for filling the lock comes out of water which is not used for power. During the past 17 years it is found that there has been a surplus of water on the average during five months of each year, and to produce this average there are some years when there is almost a continuous surplus, while the dry years serve to bring the average down.

On the days when there is no surplus of water and when whatever is used for lockage can be directly chargeable as an actual loss of water power, the value

in money of the loss of water power may be readily figured. The Essex Co. records show that the water power is sold to the users at \$300 per mill power per year. One mill power equals 85 horsepower and the cost per horsepower per year is therefore \$3.54. The mill year is on a basis of 280 days, for which the year's charge of \$300 per mill power is figured. Using this same basis for computing what part of the \$3.54 per year per horsepower may be charged per day, the actual cost of the water used in lockage, per filling of the large lock, is again found to be a negligible sum, even though it may be increased sufficiently to cover the cost of substituting steam power to offset the amount of water power lost. The actual cost per filling of the lock on the water power basis would be 48 cents in round figures. For details concerning this computation we refer to a letter from Engineer George Bowers (Exhibit F).¹

We again call your attention to the fact that on many of the 280 days of the mill year there would be a surplus of water and therefore no loss.

The basis of one vessel per day passing up through the Lawrence dam to Lowell has, for convenience in computing, been adopted; it may definitely be stated that one barge per day, 300 days in the year, each barge carrying 1,500 to 1,600 tons of coal, would serve to supply the city of Lowell with its coal, or at least that portion of it which would naturally come via the river. That other vessels besides the coal fleet would pass up to Lowell is unquestioned, but we feel that, even if the number of the daily fillings of the locks is considerably more than one, the cost of the water utilized for lockage remains at an inconsiderable figure.

The advocates of the channel feel that the largest of the locks will not necessarily be the one regularly used. When the smaller of the two main locks is utilized, the resulting use of water is materially lessened, the smaller lock taking 4.4 second-feet of the day's flow, which is the equivalent of 12.9 horsepower at this dam.

It should be noted that the mills using water power at Lawrence develop steam and electric power totaling 90,348 horsepower, as compared with 12,329 water-power horsepower, showing that, contrary to the prevailing impression concerning the cities of the Merrimack Valley, the canals furnish only about one-seventh of the power even to the mills which have an interest in water power.

In the foregoing computations we have assumed a brimful lock, and have made no allowance for the displacement of the vessel being locked through; a proper allowance for displacement will many times over care for any loss by wastage, leakage, and evaporation.

On all the evidence, therefore, we entertain no apprehensions that the establishment of a ship channel will materially affect the water power at Lawrence or that the possible traffic to be carried can, by the wildest stretch of the imagination as to future development, be a matter of concern to the users and owners of water-power rights.

Let me recapitulate the points upon which we rely in this connection.

1. As the project stops at the foot of the falls below Lowell, there will be no effect whatever upon Lowell power.

2. As the only lock is at Lawrence, only traffic going above Lawrence (i. e., to Lowell) will adversely affect water power even at Lawrence. (See footnote 2, at end of letter, p. 95.)

3. As the average 17-foot barge carries some 1,500 tons of coal (see footnote 3, at end of letter, p. 95), 450,000 tons of coal can be delivered to Lowell if but one barge a day goes up the river to Lowell the 300 working days of the year. This amount is in excess of the present coal consumption of Lowell received via all routes. Even if the number of days during which, on account of ice, etc., coal barges could come upstream should be considerably reduced, it will be seen that the number of barges passing upstream through the lock at Lawrence will not, so far as coal alone is concerned, necessarily exceed one and a fraction per day. The determination of the period when ice conditions would prevent use of the channel is difficult. When the ice breaks up in the spring there might be a period of some days when navigation would be unsafe. So far as the actual thickness of the winter ice is concerned, it would probably seldom act as a barrier if traffic were passing through the channel daily.

4. Of course each vessel would have to be locked down as well as locked up. It is probable, however, that these could oftentimes be locked in pairs, so that

¹ Not printed.

there would be no additional use of water for lockage beyond that required for the single vessel going upstream.

5. Only about 10 per cent of all the power now developed at Lawrence is developed from water power. All the mills, I understand, are fully equipped with steam or electric power, so that they could, even if there were no water power at all, operate exclusively by steam or electricity.

6. The consumption of water for purposes of lockage is practically negligible. If the large lock be used it represents a cost of but 48 cents per filling. If the small lock be used it represents but 16 cents per filling. The amount in each case is distributed among the various consumers of water power and is too minute even to be seriously considered. Indeed for half the year, when water is wasting over the dam, even the infinitesimal cost disappears. For detailed figures showing the distribution of water, steam, and electric horsepower among the various industries of Lawrence, see "Exhibit D."¹

C.

Draft of vessels using Merrimack Channel if developed.

At our conference, and also in your letter above mentioned to Col. Craighill, you expressed interest in the question whether even an 18-foot channel would in the future be deep enough to accommodate the type of vessels likely to utilize the Merrimack Channel.

In our effort to furnish some light upon this question I wrote first to the Commissioner of Navigation of the United States and by him was referred to several large carriers of coastwise freight.

I append as "Exhibit E"¹ the answers to my inquiries.

The Consolidation Coastwise Co. says in part, after referring to 26 and 27 foot draft steamers, and to the large New England trade requiring 16 to 18 foot draft coal barges:

"If it is found to be economically wise to provide an 18-foot channel from Lowell, Mass., to the sea for the purpose of taking care of the coal business exclusively, there is no necessity for considering a channel of sufficient depth to take care of the large steamers."

The Lehigh Valley Railroad Co., to whom Col. Craighill also wrote, furnishes me copy of its reply to Col. Craighill, and in its further reply to me says:

"All of the companies carrying coal in connection with the railroads operate a large number of barges from 1,500 to 1,600 tons, and that class of barge must necessarily continue in service because many of the yards can not take a greater quantity of coal than 1,500 tons at one time.

"These barges draw from 15 to 18 feet."

The Staples Transportation Co. says:

"My opinion is that with an 18-foot channel you could find plenty of tonnage to care for your coal trade in Lowell."

This company also states that the barges drawing from 21 to 26 feet are diminishing through losses and are not being replaced. A list of the fleet of this company is appended which shows that the draft of but 7 out of about 30 exceeds 17 feet. The New England Coal & Coke Co. has a fleet of 14 barges, not one of which exceeds 17½ feet draft.

The Philadelphia & Reading Railway Co. writes:

"There are some barges engaged in the coastwise trade having a loaded draft of 24, 25, and 26 feet, but these are not barges that were built for the coastwise-carrying trade. We think that it will be found that all of these long-legged craft were cut down, reconstructed, or converted from square riggers or old steamships into barges. These craft have no bearing whatever on the tendency to increase the draft of barges in coastwise traffic; they will pass out of sight in the near future.

"It is our opinion that the popular demand for barges not exceeding 17 feet to 18 feet draft loaded and of a carrying capacity of 1,500 tons or thereabouts will warrant the perpetuation of this type and class of vessel, and that there will be remaining in operation in the coastwise trade along the Atlantic seaboard in the years to come a sufficient number of barges not exceeding 17 to 18 feet draft to warrant the providing of an 18-foot channel and other proposed improvements in the rivers and harbors along the North Atlantic coast as proposed."

¹ Not printed.

This company also points out that of its fleet of 72 vessels but 5 exceed 17 feet in draft, and, referring to the large-draft barges of the Staples Co., says:

"These barges are never loaded to their full or intended capacity; they are too long for their shape, and both were badly strained on their initial trip. It is not likely that any more of that type will be built."

We feel that all the evidence is overwhelmingly to the effect that the 17-foot barge is here to stay and that the proposed Merrimack River channel, in accommodating this type of barge, will fulfill every commercial need for many years to come.

We have previously offered detailed testimony to prove that owing to the absence of water competition the prices paid for coal in the Merrimack Valley are grossly disproportionate, the rate to Lowell amounting in some cases to as much as \$1.20 a ton more than to Boston and the rate to Lawrence amounting in some cases to \$1.35 a ton more than to Boston. In times of freight congestion, such as the present, our plight is even worse. I quote from an article in the Lowell papers of October 24 last:

"Coal goes up a dollar a ton this morning. The new prices are as follows: Broken, \$9.75; egg, \$10; stove, \$10.25; No. 1 nut, \$10.25; No. 2 nut, \$9; buckwheat, \$7.50; Franklin, \$11.50; Lehigh, \$10.50. Owing to embargoes and traffic difficulties, it is now next to impossible for Lowell dealers to obtain any all-rail coal. The situation is influenced by the conditions at the mines and by the freight congestion of both railway and water transportation. The railroad embargoes cause coal to be shipped by circuitous routes, producing higher freight rates than normal. The retail dealer in Lowell is now unable to obtain coal direct from the mines."

Since October 24 prices have materially advanced and are now in the neighborhood of \$12 a ton on most grades. Yet a dispatch from Boston, quoted in the newspapers of November 3, reads:

"COAL IS MUCH CHEAPER IN BOSTON THAN IN LOWELL.

"Boston, November 2.—Retail prices of anthracite coal were increased 75 cents a ton here to-day.

"The new prices are: Pea, \$8.50; furnace, \$8.50; egg, \$9.50; stove, \$9.50; nut, \$9.50; Franklin, \$11."

Our Lowell newspapers of that same day (November 2) showed Lowell prices on coal as follows:

"PRICES IN THE RETAIL MARKETS.

"The fuel problem yesterday became more acute locally than it has at any time since the era of superhigh prices opened.

"Every grade of coal advanced, the prices varying from \$14 to \$10.75 a ton. Cannel coal goes highest, to \$14, and egg, stove, and No. 1 nut reached the \$12 mark, an advance of \$2 and \$1.75 within a week. Lehigh is at \$12.25 and Jeddo Lehigh is \$13. No. 2 nut went up \$1.75 to \$10.75 a ton, and Franklin rose to \$13.25. Cumberland jumped to \$10.75 a ton. Coke had not changed in price yesterday, although it was said a change is imminent.

"Coal.

Lehigh -----	\$12.25	No. 1 nut-----	\$12.00
Franklin -----	13.25	No. 2 nut-----	10.75
Cumberland -----	10.75	Coke -----per ton--	7.75
Broken coal-----	11.50	Otto coke-----per ton--	9.00
Egg -----	12.00	Jeddo Lehigh-----	13.00
Stove -----	12.00	Cannel coal -----	14.00 "

We in Lowell have thus recently been paying some two to three dollars a ton more than Boston prices. This, we submit, is wholly a question of freight congestion and a condition which would be obviated if the Merrimack were navigable. Our need of the channel is abundantly evident in ordinary times; it is supremely obvious in times of emergency and congestion. While, as I have repeatedly said, coal furnishes perhaps the clearest example of our needs of water transportation, many other commodities would, to our advantage, make full and profitable use of the development.

The foregoing is transmitted, not necessarily as our final statements upon the questions raised but as, we trust, sufficient evidence to overcome any doubts

which you may have had upon the points covered. If you desire further information upon these or any other points, we respectfully ask that we be given a further hearing and a further opportunity to present additional material. Nevertheless, we believe confidently that we have conclusively answered any objections growing out of the particular questions raised.

President Robert F. Marden and Secretary John H. Murphy, of the Lowell Board of Trade, have spent much time in compiling the material preliminary to the preparation of this letter and, indeed, have drafted portions of it after consultation with various hydraulic engineers. We are also indebted to Mr. George Bowers, chairman of the waterways committee of the Lowell Board of Trade; to Mr. Andrew B. Sutherland, of the Merrimack Valley Waterways Commission; to Mr. George E. Rix, of the Lawrence Chamber of Commerce, and others. I am authorized to state that Congressmen Gardner and Phelan concur in the views herein set forth.

Respectfully, yours,

JOHN JACOB ROGERS.

Gen. W. M. BLACK,
Chief of Engineers, U. S. Army.

Footnote 1: The Erie Canal in 1915 carried 1,858,114 tons of merchandise, valued at \$30,610,670. This tonnage was divided as follows:

Anthracite coal-----	227, 082	Stone, lime, and clay-----	641, 142
Bituminous coal-----	92, 238	Miscellaneous -----	575, 212
Boards and scantlings-----	207, 852		
Pulp wood-----	114, 588	Total-----	1, 858, 114

Footnote 2: If it be assumed that a portion of the freight to or from Lawrence would make use of the lock at Lawrence, a suitable allowance should be made for the additional lockages thus made necessary.

Footnote 3: In the desire to be conservative we have estimated on the basis of 1,500-ton barges. Many 17 and 18 foot draft barges (take, for example, those of the New England Coal & Coke Co.) carry comfortably 2,500 to 3,000 tons. If the large capacity barges be assumed, the number of barges to Lowell and hence, of course, the number of lockages at Lawrence can be materially lessened—perhaps halved.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, November 18, 1916.

From: The Chief of Engineers, United States Army.

To: The District Engineer Officer, United States Engineer Office, Boston, Mass.

Subject: Merrimack River.

1. I just had an opportunity to go over the indorsement on department letter of August 25, 1916, relating to the Merrimack River, Mass., which was prepared for Col. Craighill's signature, but which was handed to me by Mrs. Craighill unsigned because Col. Craighill was too ill to consider the matter. The report appears to cover the additional information desired by the Chief of Engineers, but I note it refers to certain letters received from transportation companies which were intended to be transmitted with the report when forwarded to the department. It is requested that these letters be supplied.

2. Local interests were also given an opportunity to submit additional data covering the points raised by the Chief of Engineers, and a letter has just been submitted by Congressman Rogers, accompanied by a number of exhibits which I have not yet had time to read.

H. C. NEWCOMER,
Colonel, Corps of Engineers,
Acting Chief of Engineers, U. S. Army.

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 20, 1916.

To the CHIEF OF ENGINEERS,
United States Army.

Returned, with the usual second copy of the indorsement referred to, together with the original letters from the transportation companies, as requested in paragraph 1 above.

FREDERICK B. DOWNING,
Captain, Corps of Engineers.

LETTER OF NEWPORT NEWS SHIPBUILDING & DRY-DOCK CO.

NEWPORT NEWS, VA., *November 21, 1916.*

DEAR SIR: Referring to your letter of August 30, which I greatly regret was mislaid and which has only come to light this morning, requesting information relative to draft of barges.

Barges are in most part steamers or sailing vessels converted when old, although there are many new barges built. I think it likely that shallow-draft barges will be built to suit short voyages from a local center—say Boston for New England—as unloading devices for coal are improved to such an extent as to render transshipping practicable.

This limited information I hope will reach you in time to be of some service.

Yours, very truly,

W. H. BENSON,
Assistant to the President.

Col. W. E. CRAIGHILL,
Corps of Engineers.

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 23, 1916.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

Forwarded for consideration in connection with similar letters from transportation companies in regard to future draft of barges, forwarded with indorsement of this office of November 20, 1916, on E. D. letter of November 18, 1916, relative to survey of Merrimack River.

CHAS. L. POTTER,
Lieutenant Colonel, Corps of Engineers.

LETTER OF ESSEX CO.

LAWRENCE, MASS., *November 29, 1916.*

DEAR SIR: The letter, date of November 14, 1916, signed by John Jacob Rogers, who is a Member of Congress from the Lowell district, and addressed to you, has been published in the local papers, and, assuming that it is correctly quoted, there are some statements and assumptions that require modification.

A recapitulation of the main points on which he relies is stated toward the close of his letter, and these are presented, with comments on the conclusions which are drawn, with the statement of facts which actually exist as far as can be ascertained.

If further details are required we shall be ready to cooperate with your engineers as far as possible.

Yours, respectfully,

RICHARD A. HALE,
Prin. Asst. Engineer Essex Co.

Gen. WM. M. BLACK,
Chief of Engineers, United States Army.

Memoranda of the Essex Co.

This data is stated in the letter of John Jacob Rogers to Gen. W. M. Black, Chief of United States Engineers, November 14, 1916.

Referring to the recapitulation of points in the latter portion of his letter:

No. 1.—“As the project stops at the foot of the falls below Lowell, there will be no effect whatever upon Lowell power.”

This is self-evident, as project stops at falls below Lowell.

No. 2.—“As the only lock is at Lawrence, only traffic going above Lawrence (i. e., to Lowell) will adversely affect water power even at Lawrence. (See footnote 2.)”

Footnote 2: “If it be assumed that a portion of the freight to or from Lawrence would make use of the lock at Lawrence, a suitable allowance should be made for the additional lockage thus made necessary.”

The footnote 2 modifies the first statement that the only operation of the lock would apply to Lowell freight.

The report of the Merrimack Valley Waterway Board plans a landing wharf above the dam near the head of the North Canal at Lawrence as being the most available location for general freight. It is assumed that the freight to the mills would be taken care of by unloading in the rear of the mills. The general freight for the city would have to be unloaded either below the Lawrence Gas Co.'s property near the city farm and hauled 1½ miles to the city or locked through above the dam to a landing wharf provided somewhere near the dam at the head of the canal or river front. A portion of the general freight to Lawrence should be included in this lockage in addition to the Lowell freight already mentioned. To illustrate: Assuming the Arlington Mills should have water freight, the nearest point to their mill would be at a landing wharf above the dam.

No. 3.—“As the average 17-foot barge carries some 1,500 tons of coal (see footnote 3), 450,000 tons of coal can be carried to Lowell if but one barge a day goes up the river to Lowell the 300 working days of the year. This amount is in excess of the present coal consumption of Lowell received via all routes. Even if the number of days during which, on account of ice, etc., coal barges could come upstream should be considerably reduced, it will be seen that the number of barges passing upstream through the lock at Lawrence will not, so far as coal alone is concerned, necessarily exceed one and a fraction per day. The determination of the period when ice conditions would prevent use of the channel is difficult. When the ice breaks up in the spring there might be a period of some days when navigation would be unsafe. So far as the actual thickness of the winter ice is concerned, it would probably act seldom as a barrier if traffic were passing through the channel daily.”

It is assumed that an average of 1 barge of coal a day will go up to Lowell for 300 working days to provide the necessary amount of coal for Lowell. Regarding the situation concerning the ice, the actual conditions are as follows: The river above Lawrence Dam begins to freeze over early in December and remains frozen over for a period of about three months. The ice supply of the city is generally obtained from the river and is cut when the ice is 10 inches to 12 inches or more in thickness, which generally occurs in January and February. The ice breaks up usually early in March, and the following table for a period of years shows when the river was skimmed over and also when the ice broke up and went out:

Date.	River frozen over above Lawrence Dam.	Ice went out above Lawrence Dam.
1894.....		Mar. 5-11.
1895.....	Nov. 30, skimmed over.....	Mar. 21-24.
1896.....	Jan. 25, ice 6 inches thick.....	Mar. 2-16.
1897.....	Jan. 14, ice 5½ inches thick.....	Mar. 9-13.
1898.....	Dec. 10.....	Mar. 3-10.
1899.....	do.....	Mar. 13-17.
1900.....	do.....	Feb. 13-19.
1901.....	Nov. 29.....	Mar. 11-13.
1902.....	Dec. 7.....	Mar. 1-3.
1903.....	Nov. 26.....	Mar. 1-7.
1904.....		Mar. 22-26.
1905.....		Mar. 19-27.
1906.....		Mar. 6-7.
1907.....	Before December.....	Mar. 18-26.
1908.....		Mar. 8-15.
1909.....		Feb. 22-23.
1910.....		Mar. 1-8.
1911.....		Mar. 14-15.
1912.....		Mar. 15-19.
1913.....		Mar. 10-17.
1914.....		Mar. 5-7.
1915.....		Feb. 20-27.
1916.....		Mar. 27-Apr. 1.

The statement is made that, as far as actual thickness of winter ice is concerned, it would probably seldom act as a barrier if traffic were passing through the channel daily. This would mean that an open channel of sufficient width would have to be maintained for 9 miles up to the foot of Hunts Falls throughout the winter, with interruption for a few weeks when the ice is going out.

No. 4.—“Of course, each vessel would have to be locked down as well as locked up. It is probable, however, that these could oftentimes be locked in pairs, so that there would be no additional use of water for lockage beyond that required for the single vessel going up stream.”

The proposition of locking boats by pairs is economical if arrangement can be made to have them on hand without serious delay and long waits. This would have to be determined by experience. The probability would be that during the summer and dry season the average lockage would be greater than during the winter months and the early spring, when there is a surplus of water.

No. 5.—“Only about 10 per cent of all the power now developed at Lawrence is developed from water power; all the mills, I understand, are fully equipped with steam or electric power, so that they could, even if there was no water power at all, operate exclusively by steam or electricity.”

This statement is incorrect throughout. The relative amounts of steam and water power along the canals are as follows:

Table No. 1.

	Full capacity.	Usual running.	Per cent of capacity.
Steam power—indicated horsepower	75,998	43,310	57
Water power—net horsepower.....	25,535	14,280	56
Total.....	101,533	57,590	.....
Per cent of water power.....	25	25	.....

The above table (No. 1) includes all mills drawing water from the canals, both for power and for manufacturing purposes.

There are certain mills that are driven by steam alone, using no water power, and excluding these mills the following table shows the power capacity of the mills that have combined steam power and water power:

Table No. 2.

	Full capacity.	Usual running.	Per cent of capacity.
Steam power—indicated horsepower.....	46,398	25,710	55
Water power—net horsepower.....	25,535	14,280	56
Total.....	71,933	39,990	.....
Per cent of water power.....	35.5	35.7	.....

This shows that the mills using combined steam and water power have a full capacity of one-third water power and two-thirds steam power, and that in actual running the same relation exists. Including all of the mills which develop steam power and water power the ratio is 25 per cent and 75 per cent, water and steam, respectively.

The statement that only 10 per cent of all the power now developed in Lawrence is developed from water power is incorrect as applied to the mills using steam and water power along the canals. The Arlington Mills which are not located on the canals have a capacity of about 25,000 indicated horsepower and actually use about 18,000 horsepower. This included in the other mills would make about 100,000 total indicated horsepower and the water power would equal about 20 per cent of the total. There may be steam power used in many small plants about the city which would increase the steam power slightly, but not to any great extent.

The statement that the mills are equipped with steam power so that they could operate if there were no water power is incorrect. A very few of the mills are equipped in such a manner to run temporarily by steam in case there were no water. Most of the mills, including the larger users, would be seri-

ously crippled, and, as running normally, there would be a total deficiency of about 5,000 horsepower which could not be replaced by supplementary power. This deficiency would mean practically shutting down the mills, as various departments are wholly dependent on the output of other departments.

No. 6.—“The consumption of water for purposes of lockage is practically negligible. If the large lock be used, it represents a cost of but 48 cents per filling. If the small lock be used, it represents but 16 cents per filling. The amount in each case is distributed among the various consumers of water power and is too minute even to be seriously considered. Indeed, for half the year, when water is wasting over the dam, even the infinitesimal cost disappears. For detailed figures showing the distribution of water, steam, and electric horsepower among the various industries of Lawrence, see Exhibit D.”

In the early portion of the published report it is stated that, assuming that the largest lock as proposed by the investigating engineers were used, the filling once would require an equivalent of 12.8 s. f., computed on the working day of 10 hours. This would correspond in quantity to a lock 350 feet in length by 45 feet in width and with a height of 26.3 feet. Assuming the water in the pond to be at Ref. 33 at least, the river below the lock would stand at Ref. 9.7 feet. As a fact, when no water is flowing over the dam the water at the lock outlet would stand at about Ref. 6, making a height of 32 feet, or 518,400 cubic feet, equivalent to 6 second-feet for 24 hours and 14.4 second-feet for 10 working hours, which equals 0.58 mill power.

The statement is made that 12.8 s. f. would produce 37.6 horsepower at Lawrence Dam. This would be on the assumption of 26 feet fall, which would produce 37.6 gross horsepower, or 0.44 mill power.

The fall at this point during the dry period would average 30 feet, and with this quantity would equal 42.4 gross horsepower, or about 0.5 mill power, on one lockage.

Permanent power is the power that was estimated to be available through every working day, or for 305 days in the year. Working days were at first counted as 16 hours long, but on all mill sites sold in the past 33 years they have been estimated as 12 hours long, being between the hours of 6.30 a. m. and 6.30 p. m.

For the past 50 years all mill sites that have been sold have the right to draw their designated number of mill powers upon paying \$1,200 per mill power per year, and surplus power on all of these and upon all other sites have been sold up to 50 per cent of the permanent power to which they are entitled at the similar rate of \$4 per day when used.

Each filling of the lock would cost \$2 on this basis, and the annual cost would depend on the number of lockages during the dry periods. It is reasonable to suppose that six months in the year would cover the period in which the use of the lock would affect the water power drawn by the mills, and any estimate of the annual loss of power would be dependent on the number of lockages during this period, which would probably be as many as three-quarters of the full number in each year.

RICHARD A. HALE,
Principal Assistant Engineer.

In a letter to Capt. Downing, of September 15, 1916, the amounts of water drawn were stated by the Essex Co. as follows:

	Mill power.
9 $\frac{3}{4}$ working hours (usual working day), 5,000 s. f.-----	200
Remainder of time, 2,000 s. f.-----	80

Total mills on approximately 12-hour basis----- 280

The usual running, as stated in tables, was:

	Horsepower.
204 mill power-----	14, 280
If 80 mill power included, would equal-----	5, 600

Net total----- 19, 880

Making about 20,000 horsepower on 12-hour basis that are in use by the mills in ordinary working condition.

LETTER OF HON. JOHN JACOB ROGERS.

HOUSE OF REPRESENTATIVES,
Washington, D. C., May 29, 1916.

GENTLEMEN: During my statement before your board last Tuesday, May 23, on the appeal from Col. Craighill's adverse Merrimack River report, I was asked by a member of the board whether I would approve a division of the project in such a way that the Federal Government should bear the cost from the sea up to a point just below Lawrence and the State the remainder of the cost, namely, the expense of getting into the Lawrence Pool and thence up to **Hunts Falls, just below Lowell**. At that time I was unwilling to make a positive answer, because this suggestion was new to me and I had not accessible the figures to indicate the division of cost which would result. Since the hearing I have carefully considered the suggestion, and beg to submit this letter for your consideration.

As indicated in the report of the Merrimack Valley Waterway Board (January, 1914) and by Col. Craighill in his two reports, the items of cost are as follows:

Lowell (Hunts Falls) to Lawrence Dam, including 20 per cent for contingencies-----	\$680, 400
At Lawrence-----	921, 000
Lawrence to Ward Hill-----	2, 725. 200
Ward Hill to mouth-----	2. 750, 000
Terminals, flowage rights, etc-----	3. 000. 000
Total-----	10. 076, 600

Assuming the correctness of the foregoing figures, the share of the State, if the proposed suggestion were adopted, would be \$680,400 plus \$921,000 plus \$3,000,000, or a total of \$4,601,400. The share of the Federal Government would be the remainder, \$5,475,200. Under this plan, still assuming the accuracy of the figures, the State would pay about 45 per cent of the total expenditure and the Nation the remaining 55 per cent.

I still feel that the river and harbor policy of the United States has been such that the expense of the Merrimack River project should be borne largely, if not wholly, by the Federal Government. However, if your board is unable to reach this conclusion, I am now prepared to say that the above basis of division seems to me reasonably equitable, erring rather against the State than against the Nation. I respectfully suggest, and, indeed, strongly urge, that the Federal interest in this river must necessarily extend to and include Lowell. The proposed basis of division, assuming that the Federal Government did its part and that the State failed to do its part, would mean that Lawrence would be very indifferently served by the improvement and Lowell not at all. Any Federal appropriation for the project up to the point just below Lawrence ought, therefore, to be expressly conditioned upon definite guarantees on the part of the State that it accept the project and obligation and complete its stipulated portion thereof. The foregoing apportionment would leave the United States free from any annoyance by water-power claims, by flowage controversies and every other local vexation; it imposes upon the State a financial burden almost equal to that borne by the Nation; and it insures a complete project from the sea up to Lowell.

I trust that if your board can not agree with our view, that the Federal Government ought to bear the entire expense, aside from the \$1,000,000 already appropriated by the State, it may deem just and equitable the proposed plan.

Very respectfully,

JOHN JACOB ROGERS.

The BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

HEARING BEFORE THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS, IN REFERENCE TO MERRIMACK RIVER, FROM LOWELL TO THE SEA. ACT OF JULY 25, 1912. MERRIMACK RIVER FROM LOWELL TO MANCHESTER. ACT OF MARCH 4, 1915. 10 A. M. TO 12.35 P. M., MAY 23, 1916.

Col. Abbot, Col. Biddle, Col. Taylor, Col. Newcomer, Col. Winslow, Col. Flagler, and Lieut. Col. Keller were present.

Hon. J. J. Rogers, M. C.; Hon. Michael F. Phelan, M. C.; Hon. Augustus P. Gardner, M. C.; Mr. Robert F. Marden, president, Lowell Board of Trade;

Andrew B. Sutherland, president of the Merrimack Valley Water Board; Mr. Stephen F. Sherman, of Lawrence; Mr. Walter Coulson, of Lawrence; Mr. Daniel M. Casey, secretary of the Haverhill Board of Trade; Mr. Geo. R. Rix, secretary of the Lawrence Chamber of Commerce; Hon. Edward H. Wason, of Nashua; Mr. William F. Williams, engineer of the Massachusetts Harbor and Land Commission, appeared before the board in reference to the above subjects.

Mr. ROGERS. Mr. Chairman and gentlemen, we have about 10 gentlemen here from Massachusetts who would like to speak, and we should like to ascertain, if we can, about what will be the maximum time that the board can spend in listening to the arguments. We shall confine ourselves, of course, to the time that you desire to give to us.

Col. ABBOT. We have a hearing at 12, but we have delayed you gentlemen ourselves for about a quarter of an hour, and you are certainly entitled to that. There are others coming and we will ask them to wait until about a quarter after twelve. If you can get through about a quarter past twelve, we should like to finish up by that time.

Mr. ROGERS. I trust the board will not feel unduly impatient.

Col. ABBOT. We want to learn all we can.

Mr. ROGERS. Thank you very much.

I will call first on Congressman Michael F. Phelan, of Lynn, who is one of the three Merrimack Valley Congressmen.

STATEMENT OF HON. MICHAEL F. PHELAN.

Mr. PHELAN. Gentlemen, I do not believe I will take over a minute. I am going to keep that in mind, too.

It is not my intention to go into the engineering possibilities and the feasibility of the project and the probable saving in cost in various freight rates. There are other men here who have made a study of this thing—men who, I will say, have been doing it without any selfish interest. They have been disinterested, public-spirited citizens who have gone into the thing with extreme care, and I think that since the time is limited it would be very much better to have two or three of those men allowed all the time they want.

The principal thing that I am here for is to let the board know the great interest there is in the valley among the people at large. It is not confined to a small group of men or to any particular organization. It is a matter which interests the whole valley, a population, I think, of something between three and four hundred thousand people; so that if this valley were developed now as we desire it would confer benefits upon a great industrial center. I could talk for hours about the industries there, but I do not wish to take the time. If anything occurs to me which I think has not been understood I would like perhaps a minute later.

I thank you.

Mr. ROGERS. The first extended remarks this morning will be made by Mr. William F. Williams, who is the engineer of the Harbor and Land Commission of the State of Massachusetts.

STATEMENT OF MR. WILLIAM F. WILLIAMS, ENGINEER OF THE MASSACHUSETTS HARBOR AND LAND COMMISSION.

Mr. WILLIAMS. Mr. Chairman and gentlemen, I suppose that as an engineer talking to engineers I can not expect to give you very much knowledge from a strictly engineering point of view on this subject that you do not already possess, but I would like to divide this subject into three phases and ask your consideration of this project in that broad manner: First, in relation to the transportation problem as it confronts Massachusetts; and, second, as to the effect upon various commodities that may be transported by water; and, third, as to the probable saving on the transportation of those commodities by water as compared with transportation by rail.

I shall not undertake to say a great deal about the purely engineering features except as I pass along, because, as I say, I think you must understand that more fully than I can myself.

The recent embargo on rail freights in Massachusetts has shown beyond any question of doubt that the railroads in New England are physically unable to cope with any material increase on their normal capacity for transportation; and if it had not been for the assistance offered by water lines to points like

Providence, New Bedford, and Fall River, or Boston, the most serious situation would have resulted, and no one can foresee how far the manufacturing industries of Massachusetts might have been crippled.

It is becoming more and more manifest that these water routes must be utilized to a greater extent for the carriage of bulky freight, and that the problem with relation to New England is becoming a question of distribution from the coast inland rather than distribution from the interior outward. The greater part of the manufacturing centers of Massachusetts are located on waterways or on the coast. Of course, as you recall, Massachusetts was developed from the sea. It was never developed by railroads, but it was developed from the water; and that is one reason why rail carriage in Massachusetts to-day is probably more expensive than in any other State of similar population and development in this whole country.

When Mr. Mellen first came back, I might say—of course, he started in New England—he became president of the New Haven, and he made the statement that the question of handling freight in New England was one of distribution. As a matter of fact, the whole of New England was just simply a great freight yard, and he had to get away from the idea that he had learned in the West of trunk-line systems and tonnage-miles and all those factors that the West deals with in their great long hauls. So that it is the great question of distribution; and he appreciated the part that water lines had to play in the situation, and he proceeded very promptly to secure control of all the water lines in eastern Massachusetts. That has been subject to more or less investigation, as you know. The water lines, as I say, are the salvation of the freight situation in Massachusetts to-day. When an officer of the New Haven Railroad recently made the threat that if they were separated from their Sound lines they would carry all that freight by railroad, he was just simply making a statement that he knew could not be carried out in 100 years. A very large amount of freight to Lowell and Lawrence is shipped through New Bedford. I am going to speak of New Bedford perhaps rather frequently, because I lived in New Bedford a great many years, and I was more or less intimately connected with the development of New Bedford's water facilities.

Col. ABBOT. You were city engineer there?

Mr. WILLIAMS. I was city engineer for 20 years. I took a great deal of pride in the fact that New Bedford, of course, was a seaport town many, many years ago, and probably known better throughout the world than almost any other similar port, or any port, for that matter, in the whole United States; but it apparently lost its grip on sea trade at one time and turned into a great manufacturing center. It has now, of course, begun gradually building up its sea traffic on other and entirely different lines.

It is true that just at present there is a peculiar situation in the water-carrying business on account of the great war, and, of course, the taking out of freight in everything that has any tonnage, whether it is steam or sail, and that has resulted, of course, in a tremendous increase in coastwise freights, so that the railroads at some points are really carrying more business than ever before.

As a matter of fact, there has been considerable diversion of the water traffic in New Bedford, in some lines, to the rail, for that reason, and there has been a similar increase in other lines.

From my point of view it is unfortunate that the railroads have taken this attitude toward the water carriers, because I think that the two should be coordinated and that they should work together harmoniously; because there is no reason why one should injure the other. Take, for instance, strictly coastwise express service, which is bound to come sooner or later, and which is bound to be a success. The completion of the Cape Cod Canal is going to be one step toward that development, although, of course, at the present time, the canal has not become as generally utilized as its builders hoped, but it is growing every day. I think, too, there has been a little lack of, perhaps, foresight or, perhaps, lack of money in not attempting to standardize river and harbor improvements. I think that is something that has got to be considered more or less; that harbor improvements have got to be built with an eye to the commerce they are supposed to meet, and there is no use in making a 12-foot depth where the commerce of the place requires a 16-foot depth, because, while the 12-foot depth might cost a great deal of money, if you could not get 12-foot carriers, you might just as well not have any. You have got to have depths that bear the proper relation to the commerce that you are seeking to secure.

Col. ABBOT. Just as it is with the narrow-gauge railroad.

Mr. WILLIAMS. Just exactly that, sir; and it is just exactly that situation. The tendency of the water carriers, of course, as you all know, in the coast-wise trade as well as in the foreign trade, for that matter, is to deeper drafts and larger tonnage. This is a disastrous thing now to the shoal harbors and the small ships. In that direction I am in hopes that you gentlemen will lend your assistance to several of the projects that are now before you that are aimed to coordinate with this new barge canal, which, as you know, is founded on a 12-foot depth and brings into its scope the possibility of improvements like the improvement of the Connecticut River and the Taunton River. Unfortunately, I can not say that I can see just now how that could be extended to the Merrimack, because it involves quite a long ocean trip. But the idea is that the project should have some definite relation to some existing commerce that should be of sufficient size to induce increases of the carrying trade that will meet its requirements. Of course it would be a wonderful increase in the water shipments along this coast if something in the nature of a development of a greater number of shoal carriers should be brought about. The shoal-water harbors, some of them, have lost all their business, simply because the shoal water carriers have gone out of business. I know of cases where there used to be a considerable commerce by water, and they have practically lost it all simply because they can not get vessels that will carry any cargo according to these standards of cargo, etc., on those shoal drafts.

So much for the proposition as it fits into the great scheme of transportation for New England, and especially, of course, Massachusetts, which, as you know, has a wonderful coast line with a wonderful number of harbors and several great rivers.

Coming to this project and to the engineering phase of it, of course you have before you the survey made by the Merrimack Valley Waterway Commission which dealt with the improvement of the river from Haverhill to Lowell, and then you have Col. Craighill's survey from the river to Ward Hill in Haverhill. Those are very complete, and I can not possibly add anything to them, so I am not going to undertake to dwell upon them. They have very clearly set forth in their reports that have been sent in, which of course I have before me, although I have simply heard the essential details of Col. Craighill's report read, and I have not had an opportunity to study it in detail. I have taken it for granted that until it is published it is not a matter for public expression, and so I am only going to refer to those parts of the report that have been made more or less public in the discussions and meetings that have been held in the Merrimack Valley on this question.

The most important question, as I understand it, that is raised in the colonel's report is the benefits to be secured, and he arrives at the conclusion that they are not commensurate with the cost. As I understand it, the cost of the improvement from the sea to Ward Hill, Haverhill, is estimated by the colonel on a continuous channel, a tidewater channel, to Ward Hill, at about \$8,000,000, and for a channel 200 feet wide and 18 feet deep at mean low water, or \$2,750,000 for a dam at Lions Mouth with a dredged channel above the dam and to the sea of the dimensions I have stated. The cost of the improvement above Ward Hill to Hunts Falls, as estimated by the Merrimack Valley Waterway Board, is \$5,443,600. But that included a turning basin and locks at Ward Hill, whereas all but the turning basin would be eliminated by the construction of a dam at Lions Mouth, and therefore it is proper to make a deduction of \$1,117,000 from Col. Craighill's estimate, which would bring the total cost, with a combination of both schemes, to \$7,076,600.

Col. ABBOT. That is, up to Hunts Falls?

Mr. WILLIAMS. That would carry it to Hunts Falls. As I understand, that is as far as the Merrimack Valley Commission dealt with it. They did not undertake to go through Lowell, although I think there has been some consideration given to that phase of the project, but I have not dealt with that at all.

Col. Craighill further estimates that it may cost \$3,000,000 to provide terminals, pay damages, and change bridges, and in that way he arrives at the conclusion that the total project involves \$10,000,000, and upon that \$10,000,000 there should be shown an annual saving in freight charges equivalent to 4 per cent on the cost, plus \$100,000 for maintenance and upkeep, which makes a total of \$500,000. And he gives, of course, considerable consideration, I suppose, to all the facts that were submitted to him, and he arrived at the conclusion that he could not see a return of \$500,000 per year on this investment.

Before taking that up I would like to draw your attention to another phase of this question which I think should have careful consideration, and that is how far this whole situation may be stated and considered in the light of its comparability with known developments in that State. But perhaps before I go onto that I might say a word about two matters that I understand the colonel was somewhat disturbed about—the effect of the pooling of water containing a large amount of sewage that goes into that river, and in this great pool which would be formed by the dam at the Lions Mouth, which would produce a very unsanitary situation.

Of course, that is a matter worthy of consideration; there is no question about that. But you must remember that the fresh water density of the river, of course, will go on just the same. Of course, whatever that dilution is worth to-day, it will be still worth with that dam at the Lions Mouth, and you must remember that the flow of the Merrimack River, I understand, has never fallen but once below 1,200 second-feet, and it has gone as high as 90,000, and during several months of the year it is always flowing a large amount of water. That, of course, is bound to produce a very large dilution of sewage; but that is a problem that it seems to me Massachusetts has got to deal with itself, and it does not seem as though it ought to be given too much weight in its connection with this problem, which is one of transportation. The sanitation problem, as well as other local problems, will have to be taken care of by the Merrimack Valley. I believe there is now a bill before the legislature—I do not know but what it has passed—that is leading to a special investigation of the disposal of the sewage in the Merrimack Valley.

You, of course, know that one of the earliest sand-filtration methods in the country, or in that State, was installed at Lawrence, and they have always been alive to the importance of this sewage situation; and while I do not want to lessen your labors, I think it is safe to say that Massachusetts will take care of that subject, whether transportation is offered to the Merrimack River or not.

Col. WINSLOW. But if the improvement in the river applies to the cities that go to a considerable expense to build sewage-disposal plants, should not the additional cost of this sewage-disposal plant be considered as a part of the cost to the community of this improvement?

Mr. WILLIAMS. I think not, because they have got to do that entirely independent of the river——

Col. KELLER. Has not that question been under discussion for a great many years?

Mr. WILLIAMS. Yes, sir.

Col. KELLER. Incidentally, and that is the difficulty you are now discussing?

Mr. WILLIAMS. The city of New Bedford, for instance, had a sewage problem on its hands for years, and it took hold, and after a while it came to the expenditure of \$1,600,000 to take care of it. If you had contended in 1905 and 1906 and 1907, when we were striving for water improvement, that that was unrelated to the improvement of the harbor, we would have had a hard job; but we took care of the sewage problem entirely independently of the harbor problem. You have got to do it; it is a sanitary question.

The colonel is also disturbed about the effect upon the mouth of the river by the building of a dam at the Lions Mouth. There are two jetties there, and you are attempting, by the restoring of the flow, to gradually produce a deep-water channel, and I believe it is working with a considerable degree of success. I want to say that that is a question that I am not going to go very far into, because I realize that individually you all know more about that than I do, and your collective knowledge of jetties is far ahead of anything that I can say. I think you know, as I believe I know, that the question of the operation of a jetty is one that constitutes a problem in each locality, and that no man can lay down a cast-iron rule as to what will result from the building of jetties, or just how they should be built. It is a problem that has got to be dealt with and worked out according to the necessities as they appear.

Col. KELLER. Do you believe that that objection is a very real one?

Mr. WILLIAMS. I think it is a real one, but I do not think that it is one that is beyond the power of adjustment, no matter whether you have a dam or not. The dam produces a little different situation from what would be produced if you did not have a dam, but you want to remember that there are several mighty good harbors in Massachusetts that have no river connected with them; and a river is not absolutely essential to the creation of a harbor. I would undertake to say that if you did not have any river there at all, and you had

a natural dam at the Lions Mouth, you would not be seriously concerned about the harbor there.

Col. ABBOT. In that connection there is one question which the board would like to have an answer to, if some one can give it to-day, and that is the importance or nonimportance of having on the bar at low tide the same depth that there is in the rest of the improvement at low tide. If you decrease the depth of your bar, you save a considerable cost in the improvement; but by having your coal barges arrive at the time of high water they can get over that entrance, and after they get in they will be able to go up the rest of the river, provided the depth is given inside.

That is a question that I should like to hear discussed if anybody has anything to say about it.

Mr. WILLIAMS. I will just say briefly on that that I believe every harbor needs to have additional depth, whatever you may fix as its maximum depth, and all those restraints upon progress, in and out, of shipping are a decided bar to progress. Nobody can tell under what conditions he may arrive off the bar. If you arrive off the Portland bar in a gale at low tide, you know what it means. Perhaps your friends, when they pass upon your many good qualities, will be sorry that you arrived at that particular time.

I think, gentlemen, that the minimum depth, 18 feet—I think 18 feet has been selected—should be carried right from the sea into the river to make it a real, workable, every-day proposition. If you reduce that depth, you put just that much load upon the efficiency of that improvement.

I realize, of course, as an engineer, the desire to be able to show that all improvements can return a good, liberal percentage on the investment. Unfortunately, engineers are not always able to do that. I think that is one reason why they are generally designated as a class of spenders and not of earners.

I want to say a few words as to the comparability of these developments. It is only when you are dealing with a community like the Merrimack River cities, that have no adequate water transportation, that you can really show an actual saving between water rates and rail rates, because wherever there is a development, an adequate development at any water point, you will find that the rail rates and the water rates are exactly the same.

For instance, returning to New Bedford: New Bedford has always had water rates. It did not make any difference whether it came all rail or all water; and if we had been obliged to show to Congress an actual saving between water rates and rail rates to justify the expenditure of half a million dollars in New Bedford, we could not have done it. But if anybody has any doubt as to the benefit of the improvement to New Bedford, why, they want to go there and see what has happened since that improvement started.

There has been a saving in rates, of course. It is a fluctuating thing. It depends upon the law of supply and demand. For instance, take the rate on coal. There are times when it is 75 cents. To-day it is \$2. There, of course, the railroad is a little at a disadvantage, because the railroad can not change its rates in a minute; but under ordinary circumstances the rail rate to New Bedford is 75 cents a ton, sometimes \$1. But whatever it is, the rail rate will be the same. Of course, there is no difficulty to ship to New Bedford by rail, except possibly in the case of a carload of blacksmith's coal or some special brand like that. It does not pay to ship any large lots.

Col. TAYLOR. Does not any coal get in there now all rail on account of the rates by water?

Mr. WILLIAMS. Oh, no; not even now it does not. The facilities are all based on water, and there are no rail connections with any mills in New Bedford excepting one.

Col. TAYLOR. The rail rates would be cheaper than the water rates, now?

Mr. WILLIAMS. They would be if you could handle it; but the cost of handling, under the circumstances as they exist in New Bedford, would be too great.

Col. KELLER. Does not that argument, reversed, apply to the situation at Lawrence and Lowell?

Mr. WILLIAMS. Sure.

Col. KELLER. That is the very point that Col. Craighill raised.

Mr. WILLIAMS. That is very true. I will come to that.

There are certain improvements, for instance, in New Bedford, that could not have been anticipated at the time that project was under consideration any more than the improvements that may take place in Lowell and Lawrence and

Haverhill can be anticipated to-day. For instance, there has been a large construction of public warehouses in New Bedford. There is at least one so situated that it can take advantage of the water and the rail, and then there is also still another projected by William Whitman, who, as you know—probably the colonel knows him—is a large owner in Lawrence and has built one of the biggest warehouses in the State, a warehouse that will hold 500,000 bales of cotton. Mr. Whitman has a very large investment in New Bedford, somewhere in the neighborhood of—I suppose he has spent \$10,000,000 in New Bedford, and he did it entirely on account of its location with reference to water and water transportation.

So that we can not argue that you must see the absolute return on certain commodities to justify an improvement of this kind, because they are manifesting themselves in ways that you can not foresee, and they are going to be spread over a great many commodities. I know it is sometimes argued that any such development is really, after all, only the law of subtraction; that every profit means a loss to somebody, and if water transportation is given to a community that does not need it it means that somebody else has got to lose the benefit of that. There is the situation in Lawrence and Lowell. If the railroads have got facilities there, they have got to lose them. That does not necessarily follow, because the same rail facilities that are connected up with Salem and Boston can be connected up with the water delivery point on their own water front and made just as effective at a tremendous reduction in haul, and all that expenditure that is taken up with hauling long trains of cars loaded with coal and cotton, the bulkiest freight there is, can be turned over to the smaller and more valuable freight, so that there is not anything lost by those changes, and they do not come in a minute, gentlemen. It takes years to bring all these things about; it takes years to get action that might result from Congress actually getting it completed, and it takes years to take advantage of it.

The commodities that, on its face, appear would be the most affected by this improvement, of course, are coal and cotton and lumber. I might say it is axiomatic that a water point with adequate depth will always get its coal by water. It is true of Providence; it is true of Fall River; it is true of New Bedford; it is true of Boston; and of course it is true of Salem, because that is a great reshipping point. There are lots of other points where it is not true because they have no adequate depth.

It appears that the rate on coal to Lawrence is normally 85 cents a ton more than to Boston and Salem points. It appears at Haverhill that it was 55 cents, and I understand that the recent change in the rates there has put it up to the same rate as Lawrence, namely, 85 cents, because the railroads realize that Haverhill's water advantages were not what they suspected they might be. Railroads are quite human, you know, and perhaps the best evidence is shown in the fact that they will take advantage of situations. There is no reason why they should not.

The annual consumption of coal that might be affected by water transportation seems to be generally conceded to be from 1,000,000 to 1,200,000 tons, and the saving has been variously estimated from 50 to 100 per cent of the difference in rates. But that all depends, as I have said before, on the quantity that is shipped. Somebody has said there might be 50 per cent shipped. I do not think so; I think that if there are entirely adequate facilities every bit will be shipped by water except those few special brands that of course are not ever used by any community in great quantities.

Col. ABBOT. Provided that barges do not have to wait for the tide to get in.

Mr. WILLIAMS. Exactly; and provided that they have, of course, boats of tonnage that are sufficient. But there is this advantage, that any community that can offer a tonnage in one commodity alone of 1,000,000 tons a year is going to get somebody to handle it. That, of course, is something that small communities can not do. Take Newburyport, for instance. It ought to have a better rate on coal, but they do not handle enough to pay anybody to provide for it. Comparisons are given between rates and they give a great deal of consideration to the difference in distance. They say if it costs 75 cents to Salem, why, of course, to go out around Newburyport and out around Cape Ann, up the river to Haverhill and Lawrence and Lowell, it means a great many miles more, and it is going to cost in proportion to that distance. As a matter of fact, that is not the situation. There is a great inconsistency in coal rates on the coast. New Bedford and Fall River and Boston generally get exactly the same

rate, but there is a most decided difference in the haul going to New Bedford and Fall River or going to Boston—I think Portland pays only about 10 cents a ton more than Boston. Why should you add more to go to the mouth of the Merrimack River than it would cost to go to Portland? You will not have to pay it; that is all there is to it. Those things just adjust themselves according to the business and the depth of the water that is provided.

Col. ABBOT. Is not the difference between Portland and Newburyport, then, largely due to the fact that it can get in with larger craft?

Mr. WILLIAMS. Yes, sir; at all times, as I understand it. There is no difficulty in getting into Portland at any time. I have never been in on the water side, but I understand that is so. Of course, you know.

Mr. Mills, of Lawrence, is a very able man and has made an estimate of the probable saving by water transportation. He arrives at one conclusion—that it will cost 10 cents a ton more to actually deliver coal at Lawrence than what it does now by rail. I think, as a matter of ordinary business sense, everybody knows that will not be so. By another process of reasoning he arrives at a saving of 5 cents a ton, but under those estimates he takes into account the difference in distance, which, as I say, does not hold, simply because you are going to get a rate to the critical point that is based upon the desire for business in the market, and you may get just exactly the same rate at the mouth of the Merrimack River as you have at the——

Col. TAYLOR. Do you not think that the rate to Lowell would be more than it would be to the mouth of the river?

Mr. WILLIAMS. Probably there would be an increase on account of going up the river.

Col. TAYLOR. The bridges and locks and that sort of thing would be a very decided factor.

Mr. WILLIAMS. Yes; they would be a factor. For instance, if you will look over Maj. Pillsbury's report upon the improvement of the Connecticut River, you will see that he makes an allowance of something like 15 cents a ton for taking coal from Hartford to Holyoke, going through at least one lock—I think, two—to get to the lower part of Holyoke; and making due allowance, as he says, for those expenses of going through a number of bridges, he arrives at the conclusion that it ought to cost about 15 cents a ton more. I do not know why it should cost any more to go up the Merrimack——

Col. TAYLOR. Do not the number of bridges and the number of locks that you go through increase the cost every time?

Mr. WILLIAMS. I do not think you would go through any more than you would on the Connecticut River.

Col. TAYLOR. I think you would.

Col. KELLER. There are 15 bridges on the Merrimack.

Col. TAYLOR. There are only two bridges between Hartford and Springfield.

Mr. WILLIAMS. Yes; but there are three—at least two—before you can get to Holyoke.

Col. KELLER. There are 15 on the Merrimack, according to Col. Craighill's report.

Mr. WILLIAMS. That is going to be a factor; there is no doubt about that. But at the same time you are going to get a tremendous business. It is going to be attractive, and, of course, to a man who has never gone through bridges it looks to be a terrible obstacle. It is the same difficulty they are having on the Cape Cod Canal. They have to be educated to go through narrow waterways and bridges without losing their vessels.

Col. TAYLOR. They actually make a charge in going through bridges in Boston Harbor.

Mr. WILLIAMS. Yes; but the reason there is this, that the traffic over those bridges is so great that if a vessel can not come up and get through when it reaches the bridge it may have to wait a considerable time.

Col. ABBOT. They have closed hours.

Mr. WILLIAMS. Yes; that trouble would be true on the Merrimack River for most of the bridges. It is not true in places like Fall River, where they have two bridges, or New Bedford, where they have one. The right of way is given to the vessel. She goes through the minute she gets there. Everything else is subordinated to her, and that can be done without any great detriment or hardship on traffic. At any rate, just as an opinion—and I do not say that it is better than anybody else's—I think that you may safely assume that a difference in rate—and now we are dealing with the past, of course; we can not tell

anything about what the future will be. Nobody knows, of course, what is going to be the final outcome of the water-carrying business in this country. Undoubtedly it is going to be given a great deal more attention than it has been given in the past. But dealing entirely with the figures as they have existed in the past, a difference between Salem and Lawrence of 85 cents a ton, which you will understand is entirely upon large cargoes delivered to rail points and does not indicate the rate that goes to the average shipment, even on that basis a saving of 30 cents a ton can be fairly assumed; and when you take in all the smaller shippers who have to pay a very much larger rate, it is not unreasonable to assume that 40 cents on an average may be saved on the requirements in the coal line of those cities.

Col. WINSLOW. Will this be a saving, an actual saving, or a mere saving in freight rates?

Mr. WILLIAMS. An actual saving in the cost of getting the coal.

Col. KELLER. By rail or by water?

Mr. WILLIAMS. By rail or by water.

Col. KELLER. The rates will be the same?

Col. WINSLOW. It will cost just as much to haul coal all rail afterwards as it does now. It simply means that the railroad company might pay it instead of the community. Is not that it?

Mr. WILLIAMS. I do not think so. I think it is a question of readjustment. I do not believe it costs the railroads 85 cents to haul coal from Lawrence. If it does, they ought to go broke, perhaps. I suppose that is one reason why they are not making money. I had not thought of that.

I think it is going into the future, as I say, too far for any man to undertake to say just what will happen. I think there is no doubt but what the railroads will have sufficient business to offset the loss of coal. I think if they lost every pound of coal they haul, they would be better off. If you have had any experience with the New England railroads, either as a passenger or in getting freight, you would hold up your hands forthwith for anything that would enable them to give you better service.

Cotton, of course, is a big commodity, and there are certain artificial commodities that control the shipping of cotton into New England. If you undertake to look for actual savings there you are going to have a great deal of difficulty. You have got to have faith.

The Massachusetts mills all buy cotton on samples, and the mill has got to have the identical bale from which the sample was drawn. You can not pass in any other bale as being exactly like it; you have got to have the identical bale. That results in cotton being bought up throughout the South in sample lots and hauled in 50-bale lots, by rail. I think the mills in Lawrence may buy in a little larger lots, but they do not handle quite so long staple cotton.

I do not want any exception taken to that remark, because there is sometimes a little feeling between manufacturers. New Bedford ranks as being the first manufacturing center in fine goods.

It also follows that the man who sells that cotton can attach a draft to the bill of lading, and he gets his money before the mill gets his cotton. That, of course, has been the great reason why cotton was shipped all rail.

Another thing, the mill man buys his cotton delivered. He does not pay the freight on it. It is the shipper that pays the freight, and so he has charge of the routing. The mill man has very little to do with it. A mill man once said to me—we were talking about this matter, and I asked him why he did not ship by water. He said, "I don't have anything to do with that. I buy my cotton delivered. I don't care how they ship it." I said, "Do they make you a present of the freight?" He said, "Oh, no; I suppose I pay it in the end, but I am not concerned in it." That is one reason why rail rates have controlled on cotton to such an extent; but as a matter of fact, you can get exactly the same rates to New Bedford by rail as you get by water on cotton; it does not make any difference, although a very large amount of cotton comes to New Bedford by water, though it comes in a very peculiar way. Galveston and New Orleans are the largest cotton shipping points in this country. Over 50 per cent of all the cotton raised in the United States goes out of Galveston and New Orleans, and there is not a single direct water carrier from Galveston or New Orleans to any point east of New York. There is where you may see the fine hand of the railroad—and I do not say that with any feeling of bitterness against the rail-

road, because I think it shows their business acumen; they are looking after business.

So that cotton comes around into New York and there it is reshipped onto the Sound Line boats, and goes to various points. New Bedford happens to receive a very large proportion of the cotton, larger than Fall River does, because it has this direct rail line up through Taunton and up into Lowell. That gives them a direct outlet, and so, while they receive somewhere in the neighborhood of 400,000 bales of cotton in a year, less than half of it comes by rail and the other by water; and of that that came in by water in 1914 and 1915, 148,000 bales went right through to New Bedford, which is a reshipping point.

There are certain things going on that are going to change this. You are probably aware of the fact that New Orleans has recently built a great municipal cotton warehouse, and that is going to facilitate the handling of cotton so that it can be put out by the cheapest route, and it also admits of the facilitation of the collection of money, which is another great saving.

I find that very little has been said about lumber, and yet I think there would be a most decided saving on lumber, because, based upon what Fall River or New Bedford receive, there is no reason why Lawrence and Lowell would not enjoy a saving. I think that on lumber there would be a considerable saving.

I am taking up so much time that I am going to hurry right along, and I am going to arrive at a conclusion.

The return on this investment I have arrived at in just this way. I have said there will be a million tons of coal shipped annually with a saving in cost to the consumer of 40 cents a ton, and that will mean \$400,000; and that there will be 500,000 bales of cotton on which there would be a saving of 25 cents a bale. That is only about 6 cents a hundred. I think there are about four bales to a ton, or something like that. That would be \$125,000; 32,000,000 feet of lumber on which there will be a saving of \$2 per thousand, or \$64,000. Also 8,000,000 shingles at 50 cents per thousand saving—that is not spoken of, but we receive a large amount of shingles all water. That would be \$4,000 saved on shingles, or a total of \$593,000.

I think that is a conservative estimate; and before you pass to final judgment upon it I want you to take the time to go back and read what has happened to Providence since they started to improve it. If you will recall from the report, Providence at one time had $4\frac{1}{2}$ feet of water and practically no commerce at all. They have now actually 25 feet, and will soon have 30, and their shipments via water have grown since the year 1913. They were something like 4,000,000 tons. It is given as 4,539,000, but 500,000 tons went to Pawtucket.

That is what has happened by giving Providence the advantage of an adequate channel.

I do not undertake to say whether the reports from Col. Craighill on the Merrimack River are correct or not. I think 18 feet is all right. There are a lot of barges and scows, and yet there is a very large tonnage in vessels of 17 or 18 feet draft.

Taking New Bedford, that is, of course, but one of many. Providence has actually had spent on it over \$2,500,000, and the State and city have contributed two millions, so that ultimately, as the thing stands to-day they will have spent nearly \$5,500,000 on Providence. Of course, no man can say but what that is a wonderful investment, and the same with New Bedford. Something like \$564,000 spent altogether by the Federal Government, and you can trace a return of \$1,694,000 in a half a dozen different ways, not only in freight rates, but upon the development of the city that would never have come had it not been for the improvement.

Now we come to the Connecticut River, and I say that you have, of course, an opportunity to make a very large improvement at a moderate investment, estimated at \$1,870,000. This is a happenso, and they are wonderfully fortunate in being able to get it at such a low cost, although the amount of tonnage that is to be affected, according to Maj. Pillsbury looks to be rather small; only 700,000 tons altogether; but in that he figures a return of \$200,000 or \$300,000 a year. If you apply the same basis of reasoning to the tonnage that can be affected by the improvement of the Merrimack River, of course, there would be no doubt but what the return would justify the expenditure.

Mr. ROGERS. I want to call now on three representatives of the three boards of trade in the valley, who will each confine himself to five minutes. First, the northernmost city, or the westerly city of Lowell; Mr. Robert F. Marden, president of the Lowell Board of Trade.

STATEMENT OF MR. ROBERT F. MARDEN, PRESIDENT OF THE LOWELL BOARD OF TRADE.

Mr. MARDEN. I will be very brief.

The statistics on which Col. Craighill based his report are now two or three years old or more, and you all know the acceleration of business. I will give you one instance simply to point out the way the thing is going in our valley. The freight receipts in Lowell on the Boston & Maine are \$40,000 a month larger than they were when Col. Craighill was given any statistics. We think that this is a straw which shows the way the wind blows. Throughout this whole discussion, for a number of years, we have tried in Lowell to confine ourselves to facts in the matter. We have tried to get at the bottom of it. We have not tried to ask for anything unreasonable. We have not wanted to damage existing industries in any way, and our board has attempted to get in touch with the mill men, and with Mr. Mills, the engineer for locks and canals, whom probably most of you know. Mr. Mills said unequivocally that he would not interfere with the water power in Lowell, and he further said officially to me and to the assembled mill men at a session we had that it would be very feasible to connect Hunts Falls with the frontage of the mills on the Merrimack—in fact, he was rather emphatic about it when some of the other mill men questioned it. He said it could be very easily done.

Col. ABBOT. By water or land?

Mr. MARDEN. I suspect he had in mind a rail connection over water, or something; I would not attempt to say; but at any rate he was very decided about it that it was entirely feasible to be done.

Col. ABBOT. In other words, with coal delivered at Hunts Falls it could be dumped at a reasonable price to the mills?

Mr. MARDEN. Yes, sir; carried right along right up the river inside of the channel, if it was decided to stop at Hunts Falls. We do believe, however, it would be very desirable if the channel could be carried into the basin at Lowell rather than to stop at Hunts Falls. Still, it would do at Hunts Falls.

Col. ABBOT. In that connection if it got into the pool above Lowell you would have a large wharf front for development?

Mr. MARDEN. Yes; tremendous.

Col. ABBOT. Of course you would have a much more expensive development down at Hunts Falls?

Mr. MARDEN. Yes. We have had on our committee the State engineer, George Bowers, who has made a study of the tidal scour element and has talked with Col. Craighill at different times, and he submitted a method of going through Hunts Falls, a method which has been plotted, I think, on the plans. By the way, Mr. Bowers knows the bed of the river. He served as State engineer for a great many years and dealt with the river bed, so whatever he said to Col. Craighill on that was based on actual knowledge.

We talked with Mr. Mills a number of times, and I think I ought to say that Mr. Mills is the only man in the Merrimack Valley that in any of the public hearings has offered any opposition. That is referred to in Col. Craighill's final report. We want to emphasize the one fact, that Mr. Mills states that he has talked with all of the mill agents in Lowell, and that he voiced the sentiment of every mill agent and mill treasurer in Lowell in declaring that the channel is not wanted. However, in that same hearing you will find in the record in which Mr. Mills made that statement that Mr. Flather, the treasurer of the Boot Mills, spoke in favor of it. Mr. A. D. Milliken, agent of the Hamilton Manufacturing Co.; Mr. F. A. Bowen, agent of the Appleton Co., as well as Hon. Butler Ames, head of the Heinze Electric Co. and Wamesit Power Co.; George S. Motley, president of the Lowell Gaslight Co., and others, spoke in favor of it. Furthermore, Mr. Mills was the only man to argue against the proposition and is apparently unwilling to consider it.

I think perhaps I should say, simply to show the view that he takes of this proposition, that we have here a letter from him on the subject in which he says that the dam at Lawrence would interfere with the water power; that a vessel going through at Lawrence would take 1 per cent of the water power, and if 100 vessels went through they would lose 100 per cent of water power. He has got that down in black and white.

I submit, if there were 100 vessels that went through there it is worth losing 100 per cent of the water power to get them, because the Panama Canal, as I understand it, can not possibly carry 100 vessels a day. I may be wrong, but at any rate I do not think that any of us expects that 100 vessels a day are

going through the Lawrence Dam. If they did, it would be quite a commercial proposition.

We receive Mr. Mills's opinions with all due respect. We have welcomed his assistance, even though it has been against us. Then he has served to keep us, in Lowell, along a pretty straight line of thought. As I said, we have tried absolutely to do this thing right, and all we are interested in is the actual solution of it rightly. We do not want to have the Merrimack River a ship channel just to get a ship channel and see sails and steamboats coming up the river. That would be rather bad if the business interests were to be held to strict accountability on that basis. But we have noted with a good deal of interest the recommendations made by Col. Abbot in submitting Col. Craighill's report. Col. Abbot points out the fact that there is at least a proportional interest on the part of the United States Government, and we would like to see that proportion scientifically worked out, and that without relinquishing our original position that the Merrimack River is important enough for decisive Federal action.

I think perhaps I had better not take any more of your time.

Mr. ROGERS. Do you want to leave that brief with the board?

Mr. MARDEN. I have prepared a brief which I did not take the time to read, gentlemen.

Mr. ROGERS. That may be filed, Mr. Chairman?

Col. ABBOT. Yes. We are very glad to have it.

Mr. ROGERS. The next speaker will be from Lawrence, the secretary of the Lawrence Chamber of Commerce, Mr. George E. Rix.

STATEMENT OF MR. GEORGE E. RIX.

Mr. RIX. Mr. Chairman, I shall be very brief. To start with, I have a letter from our mayor. Would you care to have me read it, or just submit it?

Col. ABBOT. Just give us the gist of it.

Mr. RIX. He says:

"Believing, as I do, in the efficacy of a deeper Merrimack River to help Lawrence develop her present industries and obtain new ones, to secure quicker and cheaper transportation for her raw materials inbound and her finished product outbound; to relieve the present overcrowded condition of the rail carriers' lines and terminals and incidental car shortage; and, finally, to place Lawrence in that close touch with the outside world which is not enjoyed by an inland city, I wish to go strongly on record as disagreeing with the district engineer, Col. Craighill, in his report that the project had no economic value.

"I deeply regret my inability to appear before you to speak in favor of this project, which has been so dear to the hearts of so many of us for so many years.

"Mr. A. B. Sutherland, who will present this letter in my absence, has unlimited data to prove to you that the project is economical and practicable.

"The city of Lawrence has pledged itself to build and maintain piers and wharves on the river front.

"The State of Massachusetts has appropriated \$1,000,000 as an evidence of good faith and belief in the project.

"At a most conservative estimate the saving on raw material alone would be in excess of the required interest on \$10,000,000.

"I wish to impress on the members of your board that I thoroughly believe in this project and that Lawrence is a unit and squarely behind it.

"It is a project of merit and is devoid of engineering objections.

"I wish to make my strongest plea for your thoughtful consideration of the arguments presented by Mr. Sutherland and that you will receive them with an open mind, unprejudiced by the adverse report of your colleague, whom we hold in the highest esteem, but with whom we fail to agree."

The brief which I have prepared, or the memorandum which I have prepared here, seems very weak in comparison with Mr. Williams's dealing with the matter, so that I will simply confine myself to a few of the statements.

Mr. John A. Bernhard, president of the Alabama & New Orleans Transportation Co., New Orleans, La., and at present engaged in promoting a \$5,000,000 barge line between St. Paul and New Orleans, is authority for the statement that coal can be profitably handled between Norfolk and Boston for 35 cents a ton and to Portland for not over 45 cents. Taking one instance of our industries there in Lawrence, that of the Lawrence Gas Co., it now uses over

40,000 tons of coal a year. That estimate was made in 1914. On this they pay 80 cents freight from Philadelphia to Boston—water freight. It is 608 miles from Philadelphia to Boston, and for a haul of 26 miles from Boston to Lawrence they pay 85 cents. They pay 18 cents unloading and handling charge in Boston and 3 cents weighing charge in Boston, making a total of \$1.86.

With an outlet on the Merrimack, freight might pay an additional 5 cents to Lawrence, but the rail haul charge of 85 cents would be wiped out, thereby effecting a saving of 80 cents and doing away with the expense of 21 cents for handling in Boston. With coal brought to Lawrence in boats and the resultant saving, steps would surely be taken to establish pockets and unloading facilities on the banks of the river. The figures which Col. Craighill used were 1914 figures. I have with me a recent canvass of all the mills, and I find that in 1915 there were better than 500,000 tons into Lawrence.

The American Woolen Co. used 170,000 tons. The Pacific Mills used 125,000 tons. The Everett Mills used 70,000 tons; the Arlington Mills, 75,000 tons, and so on down the line. They are set forth in my brief.

I might say that those were 1915 figures, which are augmented by 50 per cent this year, owing to the increase in business in raw materials of all kinds, cotton and wool having gone up at the same rate.

At 80 cents a ton saving, leaving out of the question the 21 cents handling in Lawrence, this would make a saving of \$420,000 on coal alone. This is an extremely conservative estimate, and takes no account of the tremendous tonnage in cotton, wool, lumber, pig iron, pulp wood, cement and lime, sand, granite, brick, oil, etc., which could be profitably handled by boat if the river were made navigable.

I am not going into this. There is an actual addition of 15 cents per hundred pounds at present, or \$3 a ton, on cotton from New Orleans to Boston that we have to pay, and we now pay an additional 8 cents, or \$1.60 a ton, freight from Boston to Lawrence. Ninety-eight thousand tons of cotton and wool were brought to Lawrence in 1914 by rail. This is almost double—I would almost guarantee that it has doubled—what it was in 1906, because all the mills are running to full capacity. In 1915 these figures were made up. One hundred and fifty-three million one hundred and twenty-seven thousand two hundred and forty pounds, or 76,563 tons, of less-than-carload high-class freight moved between Lawrence and New York City, and most of that is handled, as Mr. Williams said, by the boat lines on the sound, the Fall River and New Bedford Lines. Of course that would all be handled by the boat lines. About one-third of the amount of this tonnage would move in and out of Boston. If this river is opened up the whole surrounding territory is going to contribute to the tonnage of the boat lines.

During the past winter New England has been suffering from an almost utter paralysis of its rail carriers. Never before has such a condition been known. This condition would have been impossible if the Merrimack River were navigable at Lowell, Lawrence, and Haverhill, as the coal and raw material would have been handled by water.

Col. TAYLOR. Was it not frozen up solid this winter?

Mr. RIX. No, sir; it was not. The main channel of the river has not been frozen. The ice companies have had hard work to get in their crop of ice. At no time during the past winter has the river been closed by ice.

The normal number of cars in the Lawrence yard is 500 to 700. At times this past winter there were 1,700 loaded cars waiting delivery, of which as high as 800 have been coal in open cars frozen hard.

Our desire is not to cripple the railroads by taking away their business. We are quite sure that if they could be relieved of the necessity of handling coal even to our section of New England they would then be in a position to devote their equipment to the handling of high-class traffic entirely, which is now made to wait for the enormous coal tonnage which must be moved to keep the industries running.

Col. WINSLOW. Did you say that those cars were allowed to lie loaded in the Merrimack railroad yards?

Mr. RIX. Yes, sir. I go by the reports of the cars in the yard. Eight hundred cars have been there unloaded——

Col. WINSLOW. Why are they not unloaded?

Mr. RIX. The roads have not had the facilities. There would come rains and hard freezes, and they resorted to all kinds of expedients to unload those cars.

Col. WINSLOW. Then the congestion in the freight business is due to the fact that the receivers have not promptly unloaded the cars?

Mr. RIX. To a large extent; yes, sir. That has been so, of course. I am free to admit that to a certain extent the conditions this winter have been such as to have put it up to the carriers that their terminal facilities were inadequate.

Col. WINSLOW. Are these cars dump cars that are run up onto a trestle?

Mr. RIX. Largely so.

Col. WINSLOW. And they could not get them out?

Mr. RIX. Even after unloading, they were frozen up——

Col. WINSLOW. Not even with steam?

Mr. RIX. They resorted to steam, and finally built sheds and ran steam pipes and drove down perforated pipes at different points and left them overnight, and in the morning they got to work on them to work them out. They resorted to all kinds of expedients to relieve that situation.

When we consider the wear and tear on equipment, rent of foreign cars, huge increases in pay rolls, discontent of help on overtime work and demands of employees for higher wages, extra switching necessary on account of blockades, for which no charge can be made——

Col. ABBOT. Your argument there is based on the actual utilizing of the transportation via water in addition to the existing rail facilities?

Mr. RIX. Absolutely; yes, sir. We believe that the rail carriers should devote their equipment that is now tied up in the handling of coal, at their yards, more particularly—the equipment can be obtained, but the rail terminal facilities can not be increased. That was brought out very prominently in the Capital Sound line hearings before the Interstate Commerce Commission; that with the Sound lines denied to the New Haven road and the all-rail facilities developed, it would be impossible—absolutely impossible, physically impossible—to handle the tonnage by the all-rail routes, as the facilities were inadequate. They can not be developed in years or with millions of money. We have that same situation with us at the present time. The Boston & Maine road, with a boat line, were intending to make an extension of their sea freight—I will not go into that matter, but they have plans already drawn and submitted to us and have purchased the land for the erection of a new plant. That leaves them without any available grounds for an extension of their switching yards. At this time they have had to store our cars away out 15 or 18 miles on the line, to save one track—simply one pulling-in track; and it is only by superhuman efforts that they have been able to keep the yard clear and the industries going.

Col. KELLER. Has the product of those industries been badly congested?

Mr. RIX. It has, indeed. It has been seriously congested. The whole system of transportation there and the buying and selling system of mills has been put out this winter by this condition, and the larger industries, such as the American Woolen Co., have been enabled to insure that by paying the railroads for special trains. They have waited one or two days and loaded as many full cars as they could to New York City. The charge has been \$5,000 flat for a special train, crew and engine, to New York City. That is the way they have handled it. The express companies have benefited hugely. They have had, instead of one car, as they ordinarily have out of Lawrence every night, three to six cars of solid express business that should have moved by freight. The same way coming in.

Col. KELLER. Has this ever happened before?

Mr. RIX. Never that I know of; no.

Col. KELLER. All of the industries have been running full time at some periods in the past?

Mr. RIX. Not recently, I guess.

Col. KELLER. Not in 1913?

Mr. RIX. Not in 1913; not that I know of; positively not since 1910, at least.

Col. KELLER. What happened in 1910?

Mr. RIX. Recently they built enormous new mills—since that time. The railroad people had called on the industries to enlarge their unloading facilities, but they have now got all the city will give them in the way of tracks across these streets, side tracks on the streets, grade crossings, and have extended their trestles and extended their unloading facilities as fast as they could. But the fact still remains that they can not take care of it all.

Col. ABBOT. Those mills are largely coal consuming mills, are they not?

Mr. RIX. Yes, sir; very largely. Almost all the water is used for washing.

Col. TAYLOR. Were the conditions this winter very much worse than in 1907?

Mr. RIX. They are very much worse than in 1907. This is due largely to the increase in business.

Col. ABBOT. The railroad situation has stayed about the same, but you have got so much more business to handle?

Mr. RIX. Yes; so much more business to handle. The railroads have been unable to obtain money to increase their facilities. Leaving out of the question the physical part it, the inability to obtain space, the railroads have been unable to get money.

Col. NEWCOMER. Is it not the claim of the railroads that their difficulties result almost wholly from the failure of the consignees to remove goods from cars?

Mr. RIX. They do; yes, sir.

Col. NEWCOMER. In other words, it is the lack of terminal facilities or storage facilities for the consignees rather than railroad terminal facilities that has caused the condition?

Mr. RIX. You are right; there is no use in my attempting to deny that; it is so.

Col. NEWCOMER. I think, in fairness to the railroads, that that ought to be stated.

Mr. RIX. Certainly. I want to say here that I am strongly pro-railroad, as I have always been a railroad man; but at the same time I have always argued with the railroad people that this development was not going to impair their revenue, as they seemed to think it would.

Col. NEWCOMER. Of course, the railroad business does not contemplate the use of its cars for storage purposes for indefinite periods.

Mr. RIX. Very true. I never believed in it myself.

Mr. ROGERS. The next speaker is the secretary of the Haverhill Board of Trade, Mr. Daniel M. Casey.

STATEMENT OF MR. DANIEL M. CASEY.

Mr. CASEY. The time is getting so short that I will be very brief. I just wish to say that whatever has been said in reference to Lawrence and Lowell applies equally to Haverhill. The last report of the Department of the Census shows that we have 400 manufactories, as opposed to 315 at the time the figures were submitted to Col. Craighill. We are to-day the fastest growing shoe city. Forty per cent of our shoes are sold in the South and Southwest. The other day there was delivered to the Mystic Wharf in Boston over 50,000 pounds of freight which is transshipped by water to those points. We feel that if we had water development in the Merrimack River we could use that at least to Boston via Charlestown; in fact, all the way through.

The railroad situation has affected us quite viciously this winter. A great many of our shoes going to New York we had to send by way of Troy and the New York Central lines. The New York, New Haven & Hartford and the Sound lines refused to accept our shoes. Probably you understand that the railroad yards at Lowell, through which our goods had to pass in order to get to New York, is much like the neck of a bottle—very long and narrow, with very little room for expansion.

This growth of our city and the lack of transportation facilities has increased our desire for the improvement and development of the Merrimack River.

Mr. ROGERS. The next speaker is a member of the Merrimack Valley Waterway Board, a board which has reported voluminously on the upper part of this project especially, and I presume that their report is before you. I take pleasure in introducing Mr. Andrew B. Sutherland, of Lawrence, who will speak not more than 15 minutes.

STATEMENT OF MR. ANDREW B. SUTHERLAND.

Mr. SUTHERLAND. Mr. Chairman and gentlemen, when I was appointed on the Merrimack River Waterway Board I was as skeptical about the proposition of opening the Merrimack River to navigation as anyone could be, but after we began to dig into the State archives of Massachusetts and find out what commerce and trade we had on the river, I became converted to the proposition, and ever since that time I have strongly advocated it.

You have had different sets of figures submitted to you from Col. Craighill and from Mr. Williams, this morning. I am not an engineer and can not talk on that end of it, but we in Lawrence and the other ports did not confer on the

figures we presented to you. Therefore there might be a slight difference, and perhaps it is a mistake that we did not. But we feel in Lawrence that the figures we submit to you are right, and we come before you this morning to ask you to set aside Col. Craighill's reports because they are not in accordance with the facts that have been submitted to you. He assumes in this first report a cost of \$10,000,000, and that the saving will be \$400,000 or more. That is 4 per cent. We claim that his figures are far from accurate, and that is why we appeal so strongly to you, knowing that your collective judgment is better than individual judgment, and we hope you will set aside his report.

Col. Craighill does not find much fault with the engineering aspects of the situation. He devotes almost his entire reports to the commercial aspects, and he quotes three sets of figures, one submitted by Mr. Mills, engineer of the Essex Co., the company that controls the water power at Lawrence; those submitted by Congressman Rogers, of Lowell; and those by Mr. S. F. Sherman, secretary-manager of the Lawrence Chamber of Commerce. Secretary Sherman's figures show the highest saving of all figures submitted. I am prepared to stand by his figures, as they have been obtained after a great deal of study and correspondence with marine transportation companies, and are based on prewar rates from southern points to Portland, in the State of Maine, which we feel would be about the same cost as transportation to Lowell, Lawrence, or Haverhill.

In Col. Craighill's first report he figures the possible saving at 20 cents a ton, but Mr. Mills, who is an opponent of the river development project figures it at 23 cents a ton. Therefore you will see that Col. Craighill's figures are more favorable to the opponents' side than they are to the side of the proponents of the scheme.

I call attention to the fact that without any reasoning or compiling of figures Col. Craighill arbitrarily fixes the saving at 20 cents a ton on 2,500,000 tons of freight, which is about half the freight that passes in and out of the Merrimack Valley; but we all know that water-borne freight is only one-tenth to one-fifth the cost to haul by railroad, and therefore the figures of the United States engineer, being based on supposition, should not have any bearing on your decision.

Take the commodity of coal. We in Lawrence and Lowell pay railroad charges of 85 cents a ton from tidewater ports, plus 18 cents per ton for transferring from steamers or barges to railroad cars, plus 3 cents per ton for weighing, making a total of \$1.06 per ton which that coal costs us more than at tidewater places, such as Boston, Lynn, Salem, or Newburyport. We have deducted from \$1.06 the 11 cents for extra distances, which would make the same rates as those now enjoyed by Portland and receiving points in Maine, making a saving of 95 cents per ton as correctly figured by officials of the Lawrence Chamber of Commerce.

Mr. Mills's figures are so far from the real facts of the case that coming from an opponent of the scheme they may be dismissed without further consideration, although they are more favorable to the proponents than those of the United States engineer.

The figures which we present to you on five commodities of raw materials are taken from the Boston & Maine official sheets. In fact, according to reports from the mills and dealers in Lawrence, the amount of coal brought to Lawrence shows 560,000 tons instead of 385,225 tons as given by the Boston & Maine Railroad. Our argument is based on the Boston & Maine figures of 385,225 tons to Lawrence, which, figured at 95 cents a ton saving, makes a saving on that commodity of \$361,200.

The railroad figures of Lowell show 489,000 tons, which shows a saving of \$464,550, and to Haverhill, 196,112 tons, which, figured at 65 cents a ton saving, would show \$127,478. That should be figured now at 95 cents. But at 65 cents it would show a saving of \$127,478, making a total of \$953,228 saving annually on coal alone for the three cities of Lowell, Lawrence, and Haverhill, which is almost 10 per cent saving on Col. Craighill's estimate for the construction of a \$10,000,000 channel, terminal, locks, and sewerage system.

In addition to those figures there would be a further saving on Haverhill freight, as the freight charges which have recently gone into operation regarding Haverhill have raised the price on coal freight from 55 to 85 cents a ton. Most of the coal for Lowell, Lawrence, and Haverhill comes from Mystic Wharf, Boston, so that although Lawrence is 8 miles nearer Boston than Haverhill, it has paid 30 cents more per ton.

Let us take the commodity of lumber. Of lumber Lawrence received 58,000 tons, Lowell 43,409 tons, and Haverhill 50,000 tons. The saving to Lawrence would be \$55,000; to Lowell, \$41,238; and to Haverhill \$32,500, or a total saving on lumber of \$128,738.

Of cotton, Lawrence receives 24,624 tons, Lowell, 102,305 tons; a saving can be estimated at \$39,300 to Lawrence and \$164,688 for Lowell, making a total of \$203,988.

The next commodity is wool. Lawrence receives 73,712 tons, and Lowell 3,905 tons; and we here would effect a saving of \$118,000 to Lawrence, \$6,248 to Lowell, or a total saving on wool of \$124,248.

On hides and leather, which is the last of the five commodities which have been tabulated. Lowell and Haverhill are two very important centers, with 100,000 tons to each city, making a saving of \$200,000. The total for the five commodities—coal, lumber, cotton, wool, and leather—is 1,621,492 tons, with a saving of \$1,610,202. The amount of freight handled in the Merrimack Valley in Massachusetts is 5,000,000 tons a year, and there is no doubt in the minds of the proponents of this scheme that the annual saving would more than double the above figures, as no consideration has been given to the other three and a half million tons of incoming and outgoing freight.

Col. CRAIGHILL'S conclusions are very much at variance with the facts and the conditions. He quotes that the mills of Lawrence receive their coal on the land side and could not change their system to receive by water without great expense. Although the coal pockets are on the land side, many of the boilers and power plants are on the water side, and the mill people have told me if they could effect a substantial saving on coal, it would pay them to make the necessary changes to receive by water instead of rail.

The American Woolen Co., which uses 170,000 tons of coal, has considered bringing coal to tidewater at Haverhill and building a private trolley line to Lawrence for their supply. This great corporation that uses 170,000 tons of coal and employs 18,000 workers in Lawrence is in favor of this scheme; in fact, I have not found any of the larger manufacturers in Lawrence who are not in favor but who do not desire to say much in favor, because they are tied up with railroad interests and do not desire to antagonize the railroad companies. The amount of capital invested in mill interests in Lawrence totals over \$90,000,000.

Col. ABBOT. Does that statement mean that the mill owners have large holdings of railroad stock?

Mr. SUTHERLAND. Yes, sir; it does exactly mean that. So it is these interlocking-directorate interests that are opposed. But I only find one single man in Lawrence opposed to this proposition. All the others are in favor of it; absolutely in favor of it.

Col. WINSLOW. Are you merely considering saving in the freight rates, or do you expect the products will actually go by water?

Mr. SUTHERLAND. I expect that they will actually go by water, the same as they have done in New Bedford and other places.

Col. WINSLOW. Would there not be an unloading charge after you got up there?

Mr. SUTHERLAND. We have to unload now from the cars.

Col. WINSLOW. But unloading from a car and from a ship are quite different things.

Mr. SUTHERLAND. All that they can do is to go right up back of the mills and unload into their coal pockets. There would only be one unloading instead of two, if we had water transportation.

Col. WINSLOW. You would unload it right from the boat into the boilers?

Mr. SUTHERLAND. Into the coal pockets.

Col. WINSLOW. That is what you do off the cars?

Mr. SUTHERLAND. That is the way they can do.

Col. WINSLOW. Dumping coal right into a coal pocket is quite a different thing—

Mr. SUTHERLAND. They could do the same; they could make arrangements to receive their freight by water. The Pacific Mills can take a barge load of coal right on the banks of the river and dump it right into their power plant, and so could all the other large interests. You take the Arlington Mills, a mile back from the water. Still, they are in favor of this project. That is one of the biggest mills in this country.

Col. TAYLOR. It could not use it anyway?

Mr. SUTHERLAND. Oh, they figure they are going to get quite a substantial saving.

Col. KELLER. They would not carry their coal by water in all probability?

Mr. SUTHERLAND. They would; yes.

Col. KELLER. And then pay the land-transportation charge?

Mr. SUTHERLAND. It would not be large.

Col. KELLER. It costs at least 25 cents a ton.

Mr. SUTHERLAND. It might, even with that, be a great saving.

Col. WINSLOW. They would have the same unloading charge?

Mr. SUTHERLAND. Yes, sir; but that is only one feature. I can quote you here mills that use practically 325,000 tons—two mills, the Pacific and the American Woolen Co.

Col. ABBOT. In all your figures the assumption has been that the cost of unloading water-borne coal at the mills would be the same at the mills as unloading car-borne coal?

Mr. SUTHERLAND. Exactly.

Col. ABBOT. Then you should deduct from the business the cost of handling coal out of barges as compared with handling it by gravity.

Mr. SUTHERLAND. We would still have a splendid argument.

Col. ABBOT. Is there any facility for getting those cars where they can be unloaded—

Mr. SUTHERLAND. The railroads look after the mills very well, as far as they are able to.

Col. WINSLOW. Who dumps the cars when they get to your pocket?

Mr. SUTHERLAND. The mill employees dump them.

Col. WINSLOW. That certainly does not cost anywhere near as much as unloading from a boat?

Mr. SUTHERLAND. On page 3¹ Col. Craighill says:

"The great manufacturing interests of Lawrence and Lowell, whose consumption of raw materials and production of finished products are included in the statistics of the proponents and relied upon by them in justifying the proposed improvement, only three or four representatives of mills have favored the improvement, and none of the others have appeared or expressed any interest in it."

We differ with Col. Craighill on that statement, nor is it correct as far as Lawrence is concerned, for of the 129 individual establishments in Lawrence, all except one or two of them favor this improvement, and the one or two can hardly be classed as opponents, but may be put in the indifferent class.

On page 2,² article 5, Col. Craighill's last report, he says:

"The figures of 6 cents per ton for towage from the mouth of the Merrimack to Lowell and return, based on a 1,500-ton barge, appear to me too low. In towing vessels up the tributaries of Boston Harbor there is an additional charge of 1 cent per ton for steamers and barges and 3 cents per ton for sailing vessels for each bridge passed through."

Provided we deduct these charges from the figures that we have presented, we would still have a very strong case. On bridge tolls to Haverhill, there are five bridges. That matter has been brought out here when Mr. Williams was speaking. The bridge tolls would reach the sum of \$17,315. There are eight bridges to Lawrence, making \$45,880, and 13 bridges to Lowell, \$96,000, which, taken on the 3-cent rate on sailing vessels, brings the anticipated saving considerably lower, but still leaves us a splendid margin in favor of the project.

The extra cost to Lawrence through bridge tolls would be \$137,640; to Lowell, \$288,061; and to Haverhill, \$51,945. After deducting that from our estimate of \$1,610,202, it would leave us on the 1-cent charge, \$1,450,000, and on the 3-cent charge, \$1,132,554, which, even according to Col. Craighill's own adverse figuring, would show a 10 per cent saving on his highest figures estimated, namely, \$10,000,000, to give us what we desire.

We even question the expenditure of \$10,000,000, but figure the cost to hardly exceed three-fourths of that sum.

Col. Craighill's last report, paragraph 2,³ says that his principal reason for reporting adversely on this important waterway is that it would not be a paying investment. We feel that we can easily prove to any fair-minded body of men, whether in the United States service or otherwise, that the facts that we have herewith submitted more than prove that it would not only be a paying investment, but it would be a greater paying investment than any similar project which the United States has ever undertaken.

¹ Page 62 of this document.

² Page 61 of this document.

³ Page 60 of this document.

Col. Craighill says that the effect of a dam at Lions Mouth and the improvement of the river at the mouth by tidal scour would be detrimental. That is a matter which does not appear to contain any great objection even by Col. Craighill, and which can be very easily overcome, as we do not intend to divert any portion of the river from its regular course or channel, and the proposed dam would not have any perceptible effect on scour, more than the present dams.

Regarding sewerage, the matter of taking sewage out of the river has been very seriously considered by the Legislature of Massachusetts during the present term, and it has been turned over to the State board of health to devise some means to take sewage and objectionable matter out of the river.

So the State of Massachusetts is working on that feature of the river development.

Col. Craighill says:

"The most important consideration to my mind is the question of whether or not the improvement would be a paying investment for the United States to make for the benefit of our national commerce."

There can not be any question that where a saving of 4 per cent, as figured by Federal officers, on a small number of commodities would be effected it helps to enhance the benefits of our national commerce. What has come true regarding Glasgow, Manchester, and other European cities through water development would be repeated in the Merrimack Valley, where even less favorable conditions, from a manufacturing and commercial standpoint, prevail than at Glasgow or Manchester. We are away in the northeastern corner of the United States, far from all sources of production that contribute raw materials. We are under greater disadvantage than Manchester or Glasgow, because both of those cities have coal and iron in abundance in their immediate vicinity. We have to take our coal, iron, and all raw material many hundreds of miles, and therefore if it is necessary for Glasgow and Manchester to obtain water service it is certainly far more necessary for us with our consumption of almost 1,000,000 tons of coal annually.

On page 5¹ of Col. Craighill's report he states that the commerce anticipated on the river would probably never materialize. He says:

"I do not doubt that the improvement of the Merrimack River would result in a sufficient reduction on railroad rates to offset whatever saving might be made by water shipment, which is really all that is desired by the proponents of the project."

In the first place, Col. Craighill's statement that the commerce would probably never materialize on the river is in line with the argument used by the stage-coach driver. When the question of railroads was first suggested, he said that he did not see how the railroads could pay when there were not enough people traveling to keep the stage coaches filled now. His statement regarding all that the proponents of this project want is a reduction of railroad rates shows how Col. Craighill has failed to grasp a proper conception of the noble purpose which the proponents have in view.

Our purpose is not to obtain more favorable railroad rates, but to develop our **present industrial conditions** still further and give them the proper freight facilities; and it is also our desire to develop a faster and more economical route by water to New York and southern points than the railroads at the present time are able to supply. In fact, the object of the proponents of this scheme is to make Haverhill, Lawrence, and Lowell a second Glasgow or a second Manchester. Therefore, our purpose is much greater and nobler than Col. Craighill conceded.

You know, gentlemen, that you have before you at different times large appropriations for harbors, especially to develop foreign commerce. Of course, foreign commerce is what we are after; but while we are after foreign commerce, we should not forget our home commerce. The cost of the raw materials that come into the Merrimack Valley every year are greater than the entire exports of the United States were to South American countries in 1914; and the trade on our river—we question if there is any section of the United States where, on a small space of practically 20 miles, you will find raw materials brought in amounting to some \$117,000,000, and finished products going out amounting to \$196,000,000. This will show a tremendous increase over those figures. We have a trade there of practically \$314,000,000 in raw materials and finished products alone, not counting the other commodities that come in and go out to and from the valley in the course of trade. Our trade there is \$1,000 per

¹ Page 63 of this document.

capita. The foreign trade of the United States is only \$400 per capita. I am quoting you prewar figures, because we are not relying on the present figures, as they are only spasmodic.

The demand for some other method of transportation than one line of railroad was never more important than during the last year when freight from New York, which used to take three to four days, now takes in some cases 30 days, and freight from points in New Jersey takes two to three months. That is about the condition we have had to face for the last four or five months.

Considering all the facts that we have here presented, and the important place which the Merrimack Valley holds as one of the great manufacturing centers of this country, we are of opinion that you can not sustain the report furnished you by Col. Craighill, and we therefore ask you to give this matter the most serious consideration, because on it depends to a great extent the life and industry of 307,000 people in the Merrimack Valley with a trade far in excess of that of perhaps any other community in the United States.

That \$314,000,000 represents over \$1,000,000 for every working day in the year that comes in and goes out of the three cities—Lawrence, Lowell, and Haverhill. I question very much whether in any part of the United States you can find any such figures as those. It is too big a project to be turned down—in fact, I feel that this board will not turn it down. The State of Massachusetts has contributed \$1,000,000. It is ready for you when you are ready to adopt this project. They have shown their good faith in the matter. The State of Massachusetts believes in it. It is a considerable sum of money, anywhere. Seven to ten million dollars is quite a considerable sum of money, but we all feel that the expenditure would be fully justified by the return; and if you can not do it for \$1,000,000 on our part, let us know what you will do it for, what part the United States ought to pay and what should be done; but we feel that you ought to recommend the adoption of this project as far as the Lawrence dam.

I know how it is with this board. They do not want to get into a controversy with any water power company. That is one thing that you want to avoid and the United States wants to avoid: but if you recommend the project as far as the Lawrence dam, there are no water power companies that you would interfere with. When you get beyond the Lawrence dam, of course, there is, but there might be some arrangement made by the State to take care of that part. But we feel that the United States ought to pay a part where there are no complications and no interference. We think you gentlemen will consider the matter favorably.

Col. ABBOT. In that connection, if I understand you, you say that if Col. Craighill's project for the dam at Lions Mouth and for the dredging up to Lions Mouth was adopted by the United States, that would satisfy the Merrimack River people?

Mr. SUTHERLAND. No; we think you ought to come to the Lawrence Dam with your dredging.

Col. ABBOT. With your dredging?

Mr. SUTHERLAND. Yes.

Col. ABBOT. You want to dredge it above the Lions Mouth Dam to carry 18 feet to the Lawrence Dam?

Mr. SUTHERLAND. Yes, sir.

Col. ABBOT. I wanted to be sure of that. The State, then, would be, in your opinion, justified in taking up the expenditures beyond that point if anything is to be done?

Mr. SUTHERLAND. Yes, sir.

STATEMENT OF HON. J. J. ROGERS, MEMBER OF CONGRESS.

Mr. ROGERS. Gentlemen, there are two speakers who will speak very briefly after me, but as I have to go down to the Capitol shortly, I desire to make my statement at this time. I dislike to be away at this time.

In the first place, I want to read a telegram from the chairman of the harbor and land commission of the State of Massachusetts, former Representative William S. McNary. It is addressed to the Board of Engineers, by the way, and it has been handed to me and I should like to have it included in the record.

Col. ABBOT. We have read it before, Mr. Rogers.

Mr. ROGERS. Very well, sir.

The Merrimack River, as all the gentlemen of the board know, has been before the United States a great many times. I do not think that, whatever our feelings in the valley may be, we can complain that it has not been very exhaustively considered.

Col. Craighill, as you all know, reported adversely, after long study, in November, 1914. It was then recommitted to him, after a hearing on the appeal had been assigned by this board, and again last November he reported adversely.

The first ray of hope that we have seen was in the transmittal report of Col. Abbot, in the course of which he referred to the possible pro rating of the expense of the project, so that the United States might bear $27\frac{1}{2}$ per cent of the total cost; and Col. Abbot then went on to say that if the State and other interested parties will assent to such a division of the cost he hardly sees how an unfavorable report on the United States part of the work could be justified. That leads us to hope that this board, or at least one member of this board, regards the project, after careful personal study, as presenting a Federal question. The reports by Col. Craighill we feel, perhaps, did not go to that length, and our inquiry now is whether we can get the board to regard it as a Federal question with the figures presented by Col. Craighill—

Col. ABBOT. Is that Col. Craighill or Col. Abbot?

Mr. ROGERS. Col. Abbot used the figures which are presented by Col. Craighill, although Col. Craighill had not himself recommended the Federal assumption of that portion of the work.

Col. ABBOT. My position has been from the beginning that so long as the local status of the water powers were not affected by the United States works there would be some clear line of division between the State portion and the United States portion, because the water-power development of the river has been done by the agents of the State, legally appointed by the State, and, consequently, when we began to enter that part of the river and interfered with the State-produced water power we were going rather beyond the point where it was wise for the United States to interfere.

This last proposition that has been made by Mr. Sutherland is a brand-new one to me, where he suggests that we stop just below the Lawrence Dam. That question, then, as to the expense of that portion of the river above the Lions Mouth Dam and below the Lawrence Dam would change entirely those present relationships. I do not know exactly how that would come out.

Mr. ROGERS. It might be in the neighborhood of 40 and 60, perhaps, might it not?

Col. ABBOT. You would have to look into that. It is quite a different change from anything I had thought of before. The question of this being presented by the State has been in connection with a total cost up to Hunts Falls. If the State is thoroughly satisfied with 18 feet up to the Lawrence Dam, it is a wholly new proposition.

Mr. ROGERS. We believe, in the State, very emphatically in self-help principle. We have tried, as has repeatedly been said here this morning, to indicate that by legislative enactment, and that was passed in 1912 and 1913, appropriating \$1,000,000; and when it was found that the act had expired by limitation this year the legislature promptly reenacted it, and so it still stands. I do not think that can be regarded at all as the final word of the State as to what it is willing to do. I think it is what might be called earnest money.

Col. ABBOT. It is a negotiation?

Mr. ROGERS. Yes, sir. I question if any conclusion which involves the State in an expenditure of over half and perhaps over one-third would be regarded on the analogy of general river and harbor negotiations as a particularly attractive one to the State, but our position is this: We have been discouraged by adverse reports time after time here. Col. Abbot's report submits for the first time a recognition of the desirability of and some conditions of Federal aid. We want to get rid of the adverse reports; we want to have upon the books, if we can, a statement of what this project is worth to the Federal Government and what, in the judgment of the board, the State government ought to assume. In other words, we want to have a starting point at least. We have for three years given a great deal of time—I have given months of almost consecutive time—to the development of the facts in connection with this project.

Col. ABBOT. Your study of the railroad question was the most complete I have ever seen.

Mr. ROGERS. I mean to say that I put in six months, every leisure moment, with the very generous aid of the Interstate Commerce Commission, in doing everything I could along that line; and of course things change very much. You recognize that condition in the railroad world—that it is being changed as the result of the present world conditions. I do not think it is proper to consider the conditions now prevailing as normal. For example, in Lowell we are equipped to handle 8,000 or 9,000 freight cars a week. We are now forced to handle 19,000 a week, and we are simply not doing it.

I am not going into those details which have been quite fully developed this morning, but that is tangible evidence of the present difficulties under which we labor.

We pay in Lowell anywhere from 65 cents a ton to \$1.20 a ton for coal more than Boston does, although Boston is generally nearer the mine of origin than Lowell is. I do not think there can be any question at all that our problem on the railroad side is a very difficult one. One of the reports to Congress stated in 1910 that railroad freight rates throughout this section are relatively high. One of the high officers of the Interstate Commerce Commission told me day before yesterday that we in New England were paying excessive freight charges for the coal at the mine head, and Lowell and Lawrence pay an excessive proportion of that on account of the freight situation. The carriers' tariff to Boston carries a footnote in connection with their freight rates to Salem, Lynn, Newburyport, and Fall River:

"This freight rate is made to meet water competition and will not apply to any intermediate points."

That results from the fourth section of the interstate-commerce act, and, whatever the cause, it means that we are, as we feel, bearing the other man's burdens; and we say that without the slightest disrespect to the railroads, because, as repeatedly said this morning, we would do the same things ourselves.

I am just trying to gather a few of the points that I think have been left untouched, and I am not trying to make a consecutive statement at all.

One of the things read was the amount which it would cost to bring coal in barges up the Merrimack in the first place. I think it ought to be noticed that the mouth of the Merrimack at Newburyport is just about the same distance from the rest of Cape Cod as Boston Harbor is. I think if you will draw an arc of the circle that will prove to be true, so that the question resolves itself into a matter of distance via the route up the Merrimack from Newburyport, from Haverhill, or Lowell, or Lawrence, or Lynn, as the case may be.

Col. ABBOT. For barges going outside of Cape Cod; but there is a little difference in the canal.

Mr. ROGERS. It is a little nearer through the canal. We submitted in the previous hearing before Col. Craighill a signed letter from the Boston Towboat Co., which I believe is the principal towboat company in that section, and it was signed by its executive officer, as I recall, and that letter stated that the charge would be \$90 for a 1,500-ton barge. That works out at the rate of 6 cents a ton. Whether that is on account of the bridge which has been suggested this morning I do not know, but the only figure which we have, at all events, is the 6 cents charge for one going up the river as far as Lowell and a proportionate amount thereof for coal stopping at Lawrence and Haverhill.

I want also to allude to the fact that although there is but a 7-foot channel up as far as Haverhill, very abundant use of that channel has been made in Col. Abbot's preliminary report about three years ago recommending the official survey. He said full commercial advantage has been taken of water so far provided to Haverhill; and then he goes on to say that, dependent upon the mills and living between Haverhill and Lowell is a population probably more dense than anywhere else along an equal number of miles of river, navigable or not, in the United States.

We have from Lowell down to the sea about 300,000 people, and, of course, considering New Hampshire, we have also the very important cities of Manchester and Nashua, both large consumers of coal and other commodities. At Haverhill, where, as I say, there is a 7-foot channel, almost half of the coal comes by tidewater. Some years ago one-half has come in; in other years not quite a half has come in. I am not going into that coal matter any further—

Col. ABBOT. That in connection, too, with the transfer from the ocean-going barges to those small Merrimack River barges without any particular facilities at the town of Newburyport. Half of it came by water, although there was this large handling charge.

Col. WINSLOW. Does Newburyport get all its coal by water?

Mr. ROGERS. I think not, sir.

In making up our figures we eliminated the small towns and cities along the banks. In our coal figures we took just Lowell, Lawrence, and Haverhill, and in a period of business depression. They are provable figures and workable figures. There are half a dozen other towns that would bring the figures up from a million to 1,200,000 tons, even in business depression.

I would like to say one thing in conclusion about the \$10,000,000 figure. I have not personally been quite able to work out what that \$10,000,000 figure includes. For example, in paragraph 8, of his report of 1915, referring to the possibility of ultimately bringing the channel around into the lower pool, Col. Craighill says, that if that extension is made beyond the project which is supposed to stop now, at Hunts Falls----

Col. ABBOT. That is, the State project?

Mr. ROGERS. Yes; but in estimating the figures he lumps both the State and the Federal cost, as you know. He says that assuming we are going to go around to Hunts Falls leading into the Lowell pool, he is inclined to think the total approximate figure of \$10,000,000 is too small. Of course, that would be a very expensive portion of the project—to go up into the Lowell pool—we can all see that at a glance, but when he says he is inclined to think that \$10,000,000 may be too small an amount, I am wondering if it would not be very appreciably less in his view in case we stopped at Hunts Falls.

And then he goes on also into the question of the adaptation of the mills at Lawrence and Haverhill and Lowell to the receipt of coal by water, and he apparently includes that in paragraph 6 of his 1915 report as one element in the total cost.

We are unable to understand why that could properly be included in the general cost of the item either as a matter of Federal or State or municipal consideration, because that would be a question purely for the individuals concerned to decide for themselves as to whether they wished to take coal in this way.

In the third place, he includes the question of land damages and flowage rights, and estimates them as in the neighborhood of \$3,000,000. We would like very much to have that portion of the work appraised at \$3,000,000 if the Federal Government should so decide, and then turned over as a part of the State contribution, because we think, after a very careful study, that we can get out of that for a half million dollars.

Col. ABBOT. It is always advantageous to have these flowage questions handled by the States rather than by the United States, because they can handle them to better advantage.

Mr. ROGERS. I should like to say one word in conclusion about what might be called the psychological side of this thing. I think it is very natural, indeed, that engineers of the Army and outside of the Army should look with approval upon the estimate of a man like Mr. Hiram F. Mills, who is a neighbor and personal friend of mine, and who is the engineer both of the power company at Lawrence and of the power company at Lowell.

(Mr. Rogers at this point made a further statement, which, at his request, was not reported.)

Mr. Walter Coulson, of Lawrence, would like to speak about two minutes and Mr. Sherman, of Lawrence, about two minutes, and then I will ask Mr. Gardner to say a word.

Col. NEWCOMER. Do you want to say anything about the adverse report from Lowell and Manchester?

Mr. ROGERS. I asked Representative Wason, of Nashua, to come here, and he said he would come. I think they feel that theirs is secondary to this. Of course, we regard the Manchester and Nashua portion, the upper portion of the river, as cumulative merely. It undoubtedly involves considerably more engineering difficulties, and we have attempted not to bite off manifestly more than we can chew. We think we have a pretty fair mouthful just with this project alone, and we have left New Hampshire to work it out for itself.

Col. NEWCOMER. The report submitted by the division officer and the district engineer considered the division of the work between the Government and the local interests at Ward Hill. Do you think there is any probability that local interests would accept that basis of division?

Mr. ROGERS. I should like to answer that in this way. I do not think that the State of Massachusetts, the local interests, would think it was fair to pay a half or two-thirds of this proposition, although I should like to make it clear again that we are very anxious to have this board put in evidence the farthest

that it thinks the Federal Government ought to go in the way of contribution, and if it says one-third or one-fourth or one-half, we would like to have that statement offered, and not have this uncompromising adverse report of Col. Craighill's staring us in the face, because it would be exceedingly difficult——

Col. NEWCOMER. Has there been any effort of the local interests to determine the extent to which they are willing to go?

Mr. ROGERS. I attempted to indicate that at the outset by referring to this million-dollar State appropriation. Do you mean by local interests the municipal and private corporations?

Col. NEWCOMER. Every local corporation. The local waterway board recommended that it may be done upon a basis of cooperation to be determined, and I thought possibly the local interests might have studied that question with a view to coming to a decision as to what would be the limit to which they would be willing to go.

Mr. ROGERS. I think probably they thought that the burden of proof was a little bit the other way. They tried to meet the burden of proof by appropriating the \$1,000,000. They tried to meet the burden of proof by guaranteeing a substantial landing place at every point up and down the river, and still they have not agreed formally. Mr. McNary's telegram, which is already before you, indicated an anxiety to meet such things as flowage claims and matters of that kind.

Col. ABBOT. There is another question I would like to ask. The original proposition was to get the improvement in their preliminary reports up as far as into the Lowell pool, and that question would immediately make the two sections of the river from Lowell to Nashua and from Lowell to the sea one proposition. If the decision be that the section above the Lowell pool is not to be improved either by the State or by the United States, that then makes the desirability of getting from Hunts Falls to the Lowell pool very much less than it otherwise would be. There has not been anything presented to-day that I have seen showing that the delivery of these heavy freights down at Hunts Falls would be a sufficient increase of the Lowell facilities to amount to a great deal. There has been an absence of argument on that. Brought up later was this question of the improvement below the Lawrence Dam. There is not anything definitely before the board as to whether that would be an acceptable solution of the project for the improving of this section. This is a very important question, and if you could get somebody to speak on that definitely in the name of the State, as to whether they would be satisfied with that, it would give us an additional point that we would be very glad to have.

Mr. ROGERS. In regard to your first suggestion, Mr. Marden quoted Mr. Mills, the solitary public opponent of this project, as saying that facilities can very readily be placed there from a point just below Hunts Falls up along the river side of the Lowell mills——

Col. ABBOT. Yes; but he did not say how that would be handled in flood times, and I do not think that there was any very definite proposition there as to how that could be carried out. I was interested in that point very much.

Mr. ROGERS. I was not at the meeting to which Mr. Marden referred, so I do not know. I had myself supposed that it would probably be something in the nature of a railroad track running most of the way on the river edge. Mr. Sutherland's suggestion that the project stop below Lawrence I am not prepared to say anything about. I should like to know how it would work out in dollars and cents before I pass upon that. I can appreciate, of course, that from the point of view of Lawrence that would be a proper solution.

Col. ABBOT. But the largest amount of coal is involved at Lowell.

Mr. ROGERS. I think not, sir.

Col. ABBOT. I thought that the figures, as they were given this morning indicated that.

Col. FLAGLER. You intimate that that \$3,000,000 estimate for incidentals is, I think you said, very large; that the damages ought to be \$500,000. Col. Craighill included in that all the expense of the installation of proper terminals at Lowell, Lawrence, and Haverhill. Do you think it is excessive if those are included?

Mr. ROGERS. I intended to say, if I did not, at the time of the original hearings each community guaranteed proper terminals without cost.

Col. FLAGLER. But if those are included, would that be such an excessive estimate?

Mr. ROGERS. I think it would be, sir.

Col. FLAGLER. You still think it would be excessive?

Mr. ROGERS. I think it would, naturally. I am not an expert on this subject; I am a mere dabbler into this very, very large problem.

I will ask Mr. Gardner to address the board briefly.

Mr. GARDNER. I am not prepared to address the board. Mr. Rogers is speaking for me.

Mr. ROGERS. Mr. Walter Coulson.

STATEMENT OF MR. WALTER COULSON.

Mr. COULSON. Gentlemen, we are impressed with the fact that an adverse report from Col. Craighill is a handicap which we must contend against, but considering that report in the light of the evidence which has been presented and which is before this board for consideration, we feel it should not be an insurmountable obstacle; and considering further the fact that under the jurisdiction of the Commonwealth of Massachusetts a most thorough investigation of this project has been conducted, and conclusions have been arrived at based upon facts which are incontrovertible, it does not seem that the adverse report of any one man, no matter who he may be, should be accepted without every man on this honorable board of appeal weighing the evidence carefully.

The Commonwealth of Massachusetts has arrived at conclusions. It feels sure of its grounds. It has shown its faith in the same by a substantial appropriation. Its investigations have been most thorough. The labor of many skillful men has been expended for years past in gathering data which are accurate and reliable and uncontradicted to prove to you that the Merrimack River is practically the only stream in the world that has a commerce of hundreds of millions annually already developed, and untold millions to be developed, which has been absolutely neglected by the General Government, so far as navigation is concerned, and left entirely to its own salvation.

It can challenge the world to point out another river in either the Eastern or Western Hemisphere that has the volume of water, the population on its banks, the developed industries and developed commerce, and the natural resources and tremendous possibilities for future expansion, and yet, although it has contributed generously toward the development of rivers and harbors in all parts of this country of infinitely less importance, there has been no reciprocation in its behalf.

Notwithstanding this adverse report, the people of Massachusetts know what they have in the Merrimack River and they know what their rights are. Until recent years they have been asleep to their rights; they have gone along industriously with their own developments and have been prospering slowly, without lifting their heads to take a wider survey and to say to the General Government, "Here we may be able to get along without you, but we will make much more rapid strides with your help. We have helped others for decades by our contributions toward the General Government. Now, come and help us, and we will return a hundredfold by the acceleration we will get by the help which it is the function of the General Government to give us."

We mean business now, and we do not propose, after having satisfied ourselves by data which can not be questioned that we have the one river of magnitude in the world that has been neglected, that this neglect shall continue, and until we have exhausted every remedy to have this wrong righted we shall proceed.

An adverse report of no one man should block a great project that is believed in by the entire body of a great State, with the exception of a few having selfish interests to the contrary, a project which will be of lasting benefit to a dense population in the Merrimack Valley and the means of creating their shores into commercial ports of national and world importance.

We trust that the hearing in this appeal will interest this board enough to cause every man on this board of appeal to read the evidence and try to discover for himself in the light of the evidence how an adverse report could be made based on such evidence. With the evidence before you, each has the same opportunity as had Col. Craighill to arrive at an independent conclusion. The evidence has been gathered after great labor and diligence, and has the prestige and dignity of having been gathered under the jurisdiction of the commission appointed by the great and General Court of Massachusetts, who are prepared to vouch for its accuracy, and with proper regard for the comity and courtesy due to the State of Massachusetts it should not be pushed aside lightly.

In an appeal to the full bench of our Supreme Court of Massachusetts the decision of the lower court undoubtedly bears weight, but when the appeal goes up on the whole evidence, that evidence is read and considered carefully by each of the supreme justices, and if they find the decision is not justified by the evidence, there is no hesitation on their part to set it aside. Should we not expect the same from this board?

In a case I recently argued before our supreme court, on which I went up on the whole record from an adverse verdict of a jury caused by the prejudiced and unfair charge of the trial justice, after reviewing the evidence and commenting on the charge excepted to, the supreme court ended by saying:

"The great preponderance of the evidence was the other way. That is enough."

And it handed down a decision in my favor.

May we not hope that after this board has carefully read and considered the record of the evidence presented to them in this case and then compares with this the adverse report, that your board will say, in the words of our supreme justices, "The great preponderance of the evidence is the other way; that is enough"?

The Merrimack Valley is to-day hampered, annoyed, and retarded by lack of freight facilities. We have reached a certain growth; we have the natural features to enable us to expand away beyond this, but we are surrounded by a steel band. We must ask you to burst it for us, so that we may expand. We are fed by artificial means through congested areas, narrow and limited rails bringing in and taking out our commodities by the spoonful, when nature intended that it should be shoveled to us through the great artery which God created to nourish and develop our fruitful valley.

No other government in the world would fail to help out nature that has been so lavish in giving us a broad, expansive river for the development of our country. No other nation would drive us to the narrow by-ways for trade when there was a broad expansive highway to our door which needed but a little top dressing to make it perfect. We feel the prosperity is here to stay. The foolish and sad struggle across the ocean has impoverished Europe. Our securities which they held and on which we were paying millions in coupon dividends, are now returned to us, and in addition we have all their bonds we can digest. All the dividends and interest on their bonds and ours will now be enjoyed by us and the money kept in this country. The Europeans will be our slaves for years to come. As a result we must prosper and expand, and all shackles which prevent us from doing so must be broken.

We look to you gentlemen to break these shackles for us in the Merrimack Valley, to give the finishing touches to a noble river, so that not only the inhabitants on its banks, but the whole United States may have the full benefit of its great commercial—not possibilities, but certainties.

Mr. ROGERS. Gentlemen, if we can have just two or three minutes more, I should like to have Mr. Sherman address you.

STATEMENT OF MR. STEPHEN F. SHERMAN.

Mr. SHERMAN. Mr. Chairman and gentlemen, supplementing what Mr. Williams and Mr. Sutherland have said as to what the possible decision would be if there was a water-borne traffic to Lawrence, I went over the work of compiling statistics as to what that commerce was to-day, not as to what it might be, and on that matter, based on known rates of freight to-day, with which I was familiar, by reason of having been in the shipping business for many years. I feel certain that there would be a saving for the city of Lawrence alone of upward of \$600,000. Two of the largest firms in Lawrence have signified to me the fact that they would only be too glad to use the waterway on the Merrimack if it was improved. There would be a saving of \$100,000—\$50,000 to the Lawrence Gas Co. and \$50,000 to the National Pulp & Paper Co. That is \$100,000 of a possible \$500,000 required by Col. Craighill to pay 4 per cent.

To show the importance of Lawrence as it relates to the rest of the country in this improvement, I want to say that of all the manufactured products of the United States 42 per cent come from the New England States, and of that 42 per cent 63 per cent of the raw material comes from the Mississippi Valley; that there is a rate of 14 cents freight as against a reasonable charge of 8 cents to other portions of the United States, so that the valley is handicapped by 6 cents on the products that it produces.

The commerce of the Merrimack Valley, as it exists to-day—not as it may exist, as you gentlemen may know, by looking at the statistics—is \$6,000,000 greater than the greatest commerce ever enjoyed by the Erie Canal in the highest year of its prosperity. The highest commerce that has ever passed through the Erie Canal in any one year was \$308,000,000, and, as Mr. Sutherland has told you, the commerce of the Merrimack Valley as compiled from the census reports was \$314,000,000.

Consequently, you have not got to figure on what the commerce might be, but what it is to-day. The rates of freight would be governed in the improvement of the Merrimack Valley by what exists to-day to other ports. For instance, you may ship coal from Perth Amboy to all the coal terminal ports, Port Johnson, and Middletown, Conn., for 46 cents. In a conversation I had with the superintendent of a large coal company, he stated that 40 cents a ton from any one of those ports would give a fair profit to the carrier, and if you add 20 cents to that for a freight rate up to the Merrimack Valley you would then only have a 60-cent rate as against \$1.85.

Consequently, I figure that there should not be less than \$1 per ton saving on coal. I want to state, gentlemen, that if this project is adopted, that what you would save on Lawrence alone would be at least \$500,000.

Mr. ROGERS. That is all, Mr. Chairman. We thank you very much.

The CHAIRMAN. We thank you for the well-prepared evidence you have submitted.

PAPERS PRESENTED AT HEARING RELATIVE TO MERRIMACK RIVER, MASS., MAY 23, 1916.

Gentlemen of the board, we come before you to ask you to set aside Lieut. Col. Craighill's report, whereby he reports unfavorably on the Merrimack River navigation project from the sea to Hunts Falls, Lowell, which enterprise was partially indorsed by his predecessor, Col. Abbot. We ask you to set aside that report, as it is not in accordance with the facts which we have presented. To turn down a project which would cost, according to Col. Craighill, \$10,000,000 figured at 4 per cent equals \$400,000 and \$100,000 for maintenance, making a necessary saving of \$500,000, when we have figured that at the lowest possible estimate the annual saving would be over \$1,000,000, or more than twice Col. Craighill's estimated necessary saving for the enterprise to receive his indorsement. We know more emphatically to-day than ever that the best project for river navigation in the United States is the Merrimack River. The conclusions of Col. Craighill are so remote from the facts of the case, and knowing that collective judgment is better than individual judgment, we make this appeal to you. Col. Craighill dismisses most of the engineering problems as apparently unworthy of consideration, being easily overcome, and so far we agree with him. He passes to the commercial aspects, and to that he devotes his entire arguments, but it is our opinion that his entire arguments fail to justify the stand he has taken. He quotes three sets of figures—those submitted by Mr. Mills, engineer of the Essex Co., the company that controls the water power at Lawrence; those submitted by Congressman Rogers, of Lowell; and those by Mr. S. F. Sherman, secretary-manager of the Lawrence Chamber of Commerce. Secretary Sherman's figures, although showing the highest saving of all the figures submitted, I am prepared to stand by, as they have been obtained after a great deal of study and correspondence with marine transportation companies and are based on prewar rates from southern points to Portland, Me., which we feel would be about the same cost as transportation to Lowell, Lawrence, or Haverhill.

In Col. Craighill's first report he figures the possible saving at 20 cents a ton, but Mr. Mills, who is an opponent of the river development project, figures it at 23 cents a ton. Therefore, gentlemen, you will see that Col. Craighill's figures are more favorable to the opponents' side than they are to the side of the proponents of the scheme.

I call attention to the fact that without any reasoning or compiling of figures Col. Craighill arbitrarily fixes the saving at 20 cents a ton on 2,500,000 tons of freight, which is about half the freight that passes in and out of the Merrimack Valley, but we all know that water-borne freight is only one-tenth to one-fifth the cost of haul by railroad; therefore the figures of the United States engineer, being based on supposition, should not have any bearing on your decision.

Take the commodity of coal. We in Lawrence and Lowell pay railroad charges of 85 cents a ton from tidewater ports, plus 18 cents per ton for transferring from steamers or barges to railroad cars, plus 3 cents per ton for weighing, making a total of \$1.06 per ton that coal costs us more than at tidewater places such as Boston, Lynn, Salem, or Newburyport. We have deducted from \$1.06 the 11 cents for extra distances, which would make the same rates as those now enjoyed by Portland and receiving points in Maine, making a saving of 95 cents per ton, as correctly figured by officials of the Lawrence Chamber of Commerce. Mr. Mills's figures are so far from the real facts of the case and coming from an opponent of the scheme, that they may be dismissed without further consideration, although they are more favorable to the proponents than those of the United States engineer. The figures which we here present to you on five commodities of raw materials are taken from the Boston & Maine official sheets. In fact, according to reports from the mills and dealers in Lawrence, the amount of coal brought to Lawrence shows 560,000 tons instead of 385,225 tons as given by the Boston & Maine Railroad. Our argument is based on the Boston & Maine figures of 385,225 tons to Lawrence, which figured at 95 cents a ton saving makes a saving on that commodity of \$361,200. The railroad figures of Lowell show 489,000 tons, which shows a saving of \$464,550, and to Haverhill, 196,112 tons, which figured at 65 cents a ton saving would show \$127,478, making a total of \$953,228 saving annually on coal alone for the three cities of Lowell, Lawrence, and Haverhill, which is almost 10 per cent saving on Col. Craighill's estimate for the construction of a \$10,000,000 channel, terminals, locks, and sewerage system.

In addition to these figures there would be a further saving on Haverhill freight, as the freight charges which have recently gone into operation regarding Haverhill have raised the price on coal freight from 55 to 85 cents a ton. Most of the coal for Lowell, Lawrence, and Haverhill comes from the Mystic Wharf, Boston, so that although Lawrence is 8 miles nearer Boston than Haverhill, it has paid 30 cents more per ton.

We will next take the commodity of lumber. Of lumber, Lawrence receives 58,000 tons, Lowell 43,409 tons, and Haverhill, 50,000 tons. The saving to Lawrence would be \$55,000, to Lowell \$41,238, and to Haverhill \$32,500, or a total saving on lumber of \$128,738.

Of cotton, Lawrence receives 24,624 tons, Lowell 102,305 tons, a saving can be estimated at \$39,300 to Lawrence and \$164,688 for Lowell, making a total saving of \$203,988.

Take wool. Lawrence receives 73,712 tons and Lowell 3,905 tons, and we here would effect a saving of \$118,000 to Lawrence and \$6,248 to Lowell, or a total saving on wool of \$124,248.

On hides and leather, which is the last of the five commodities which have been tabulated, Lowell and Haverhill are two very important centers with 100,000 tons to each city, making a saving of \$200,000; the total for the five commodities—coal, lumber, cotton, wool, and leather—of 1,621,492 tons, with a saving of \$1,610,202. The amount of freight handled on the Merrimack Valley in Massachusetts is 5,000,000 tons a year, and there is no doubt in the minds of the proponents of this scheme that the annual saving would more than double the above figures, as no consideration has been given to the other three and a half million tons of incoming and outgoing freight.

Col. Craighill's conclusions are very much at variance with the facts of the conditions. He quotes that the mills of Lawrence receive their coal on the land side and could not change their system to receive by water without great expense. Although the coal pockets are on the land side, many of the boilers and power plants are on the water side, and the mill people have told me if they could effect a substantial saving on coal it would pay them to make the necessary changes to receive by water instead of rail.

The American Woolen Co., who uses 170,000 tons of coal, have considered bringing coal to tidewater at Haverhill and building a private trolley line to Lawrence for their supply. This great corporation that uses 170,000 tons of coal and employs 18,000 workers in Lawrence is in favor of this scheme; in fact, I have not found any of the larger manufacturers in Lawrence who are not in favor, but who do not desire to say much in favor because they are tied up with railroad interests and do not desire to antagonize the railroad companies. The amount of capital invested in mill interests in Lawrence totals over \$90,000,000.

On page 3,¹ Col. Craighill says: "The great manufacturing interests of Lawrence and Lowell, whose consumption of raw materials and production

¹ Page 62 of this document.

of finished products are included in the statistics of the proponents and relied upon by them in justifying the proposed improvement, only three or four representatives of mills have favored the improvement, and none of the others have appeared or expressed any interest in it."

We differ with Col. Craighill on that statement; nor is it correct as far as Lawrence is concerned, for of the 129 individual establishments in Lawrence all except one or two of them favor this improvement, and the one or two can hardly be classed as opponents, but may be put in the indifferent class.

On page 2,¹ article No. 5, Col. Craighill's last report, says: "The figures of 6 cents per ton for towage from the mouth of the Merrimack to Lowell and return, based on a 1,500-ton barge, appears to me too low. In towing vessels up the tributaries of Boston Harbor there is an additional charge of 1 cent per ton for steamers and barges and 3 cents per ton for sailing vessels for each bridge passed through. This is verified by the following quotations from Congressman Rogers."

Provided we deduct these charges from the figures that we have presented, we would still have a very strong case.

On bridge tolls to Haverhill: There are 5 bridges, and the bridge toll, according to Col. Craighill, for steamers would reach the sum of \$17,315; 8 bridges to Lawrence, making \$45,880; 13 bridges to Lowell, \$96,000. Taken on the 3-cent rate on sailing vessels, which brings the anticipated saving considerably lower, it still leaves us a splendid margin in favor of the project. The extra cost to Lawrence through bridge tolls would be \$137,640, to Lowell \$288,061, and to Haverhill, \$51,945. After deducting that from our estimate of \$1,610,202 would leave us on the 1-cent charge \$1,450,987 and on the 3-cent charge \$1,132,554, which, even according to Col. Craighill's own adverse figuring, would show a 10 per cent saving on his highest figures estimated—namely, \$10,000,000 to give us the facilities we desire. We even question the expenditure of \$10,000,000, but figure the cost to hardly exceed three-fourths of that sum.

In Col. Craighill's last report, paragraph 2,² he says his principal reason for reporting adversely on this important waterway is that it would not be a paying investment. We feel that we can easily prove to any fair-minded body of men, whether in the United States service or otherwise, that the facts that we have herewith submitted more than prove that it would not only be a paying investment, but it would be a greater paying investment than any similar project which the United States has ever undertaken.

Col. Craighill says that the effect of a dam at Lion's Mouth and the improvement of the river at the mouth by tidal scour would be detrimental. That is a matter which does not appear to contain any great objection, even by Col. Craighill, and which can be very easily overcome, as we do not intend to divert any portion of the water of the river from its regular course or channel and that the proposed dam would not have any perceptible effect on scour more than the present dams. Regarding sewerage, the matter of taking sewerage out of the river has been very seriously considered by the Legislature of Massachusetts during the present term, and it has been turned over to the State Board of Health to devise some means to take sewerage and objectionable matter out of the river.

In paragraph 3,³ Col. Craighill says: "The most important consideration to my mind is the question of whether or not the improvement would be a paying investment for the United States to make for the benefit of our national commerce." There can not be any question that where a saving of 4 per cent, as figured by Federal officers, on a small number of commodities would be effected helps to enhance the benefits of our national commerce. What has come true regarding Glasgow, Manchester, and other European cities through water development would be repeated in the Merrimack Valley, where even less favorable conditions, from a manufacturing and commercial standpoint, prevail than at Glasgow or Manchester. We are away in the northeastern corner of the United States, far from all sources of production that contribute raw materials. We are under greater disadvantages than Manchester or Glasgow, because both of those cities have coal and iron in abundance in their immediate vicinity. We have to take our coal, iron, and all raw materials many hundreds of miles, and, therefore, if it is necessary for Glasgow and Manchester to obtain water service, it is certainly far more necessary for us, with our consumption of almost 1,000,000 tons of coal annually.

On page 5³ of Col. Craighill's report that the commerce anticipated on the river would probably never materialize, he says: "I do not doubt that the im-

¹ Page 61 of this document.

² Page 60 of this document.

³ Page 63 of this document.

provement of the Merrimack River would result in a sufficient reduction on railroad rates to offset whatever saving might be made by water shipment, which is really all that is desired by the proponents of the project." In the first place, Col. Craighill's statement that commerce would probably never materialize on the river is in line with the argument used by the stage-coach driver. When the question of railroads was first suggested, he said he did not see how the railroads could pay when there were not enough people traveling to keep the stage coaches going. That his statement regarding all that the proponents of this project want is a reduction of railroad rates shows how Col. Craighill has failed to grasp a proper conception of the noble purpose which the proponents have in view. Our purpose is not to obtain more favorable railroad rates, but to develop our present industrial conditions still further, and give them the proper freight facilities, and it is also our desire to develop a faster and more economical route by water to New York and southern points than the railroads at the present time are able to supply. In fact, the object of the proponents of this scheme is to make Haverhill, Lawrence, and Lowell a second Glasgow or a second Manchester. Therefore our purpose is much greater and nobler than Col. Craighill conceives."

Now I will give you gentlemen some of the other facts and figures regarding the Merrimack Valley, and how it compares with other parts of our country and other parts of the world:

Some important facts about the Massachusetts part of the Merrimack Valley.

[Compiled from the archives in the state house of Massachusetts.]

Total population of cities and towns adjoining the Merrimack River in Massachusetts.....	307, 540
Total value of assessed estates.....	\$262, 710, 204
Total number of manufacturing establishments.....	814
Total capital invested.....	\$188, 152, 336
Total number of wage earners employed during year.....	85, 069
Total wages paid during the year.....	\$42, 004, 459
Total value of stock and materials used.....	\$116, 870, 360
Total value of product.....	\$196, 595, 077
Total value of raw material and product combined.....	\$313, 465, 437

The value of the raw material used, plus the value of the finished product, equals $7\frac{1}{2}$ per cent of the entire foreign trade of the United States.

It equals in value $12\frac{1}{2}$ per cent of the entire foreign trade of France.

It equals in value 30 per cent of the foreign trade of Canada, where \$360,000,000 has been spent on rivers and harbors to develop foreign commerce.

It almost equals in value 25 per cent of the foreign commerce of Austria-Hungary or the Russian Empire.

It is 50 per cent of the entire foreign trade of China and more than 50 per cent of the entire foreign trade of Japan.

It is greater in value than the foreign commerce of any of the countries in the Western Hemisphere with the exception of the United States, Canada, Brazil, and the Argentine Republic.

It exceeds in value the foreign commerce of any of the seaports in the Western Hemisphere with the exception of New York and Buenos Aires.

The value of the raw material used is greater than all the exports of the United States to all South American countries in 1914.

Regarding seaports.

It exceeds the foreign trade of Galveston by over.....	\$24, 000, 000
It exceeds the foreign trade of New Orleans by over.....	61, 000, 000
It exceeds the foreign trade of Boston by.....	97, 000, 000
It exceeds the foreign trade of Manchester, England (where \$100,000,000 has been spent in constructing a canal 36 miles long with an extensive system of docks) by.....	37, 000, 000
Traffic on Manchester ship canal 5,000,000 tons, the same amount as now handled in the Merrimack Valley.	
It exceeds the foreign trade of Glasgow, Scotland (where \$55,000,000 has been spent in dredging and dock construction) by.....	66, 000, 000

It represents trade of over \$1,000,000 per day for every working day in the year.

The foreign trade of the United States is \$400 per capita.

The trade of the Merrimack Valley is over \$1,000 per capita.

Almost all this immense freight amounting in value to over \$1,000,000 per day is brought in and goes out by railroad on account of not having water transportation facilities.

The demand for some other method of transportation other than one line of railroad was never more important than during the last year when freight from New York, which used to take 3 to 4 days, now takes in some cases 30 days and freight from points in New Jersey takes 2 to 3 months.

Considering all the facts that we have here presented, and the important place which the Merrimack Valley holds as one of the great manufacturing centers of this country, we are of opinion that you can not sustain the report furnished you by Col. Craighill, and we therefore ask you to give this matter the most serious consideration, because on it depends to a great extent the life and industry of 307,000 people in the Merrimack Valley, with a trade far in excess of that of perhaps any other community in the United States. We are of opinion that Col. Craighill's report should not be sustained, as we consider that his estimate of 20 cents a ton saving on 2,500,000 tons of freight is merely guess work, and that his estimate of \$10,000,000 is excessive. We feel that the evidence we have presented to him has not been thoroughly considered, and that, in turning down such a meritorious project, he has been guided more by the adversaries of the project than by the facts and figures presented to him.

If you can not sustain this appeal in its entirety, in view of the fact that the State of Massachusetts has shown its good faith in this project by voting \$1,000,000 to spend along with the Federal Government, you ought to say what part of this project the State ought to pay. If some agreement could be arrived at whereby the Federal Government would carry out this scheme as far as the Lawrence dam, the State of Massachusetts to pay the expense of cutting through the Lawrence Dam and dredging as far as Hunts Falls. If you can not recommend the whole project, you at least ought to tell us what proportion you feel that the United States would be justified in undertaking. We will tell you now, that for the United States to undertake the improvement as far as Ward Hill only, will not be satisfactory to the people of the Merrimack Valley. We are not in any position to pledge the State, but we feel that a project full of so much benefit not only to the Merrimack Valley but to New England and the United States ought to demand from you more than negative reply. We do not know what an array of facts and figures is necessary to convince such a splendid body as this, but we do know that if these figures were submitted to an impartial body of men that their verdict would be entirely in our favor. We therefore place the entire matter in your hands having faith in your engineering and commercial judgment that you will let us know at the earliest possible moment how far you can recommend the United States to go with the project.

LETTER OF THE MAYOR OF LAWRENCE, MASS.

MAY 20, 1916.

GENTLEMEN: Believing, as I do, in the efficacy of a deeper Merrimack River to help Lawrence develop her present industries and obtain new ones; to secure quicker and cheaper transportation for her raw materials inbound and her finished product outbound; to relieve the present overcrowded condition of the rail-carriers' lines and terminals and incidental car shortage; and finally, to place Lawrence in that close touch with the outside world which is not enjoyed by an inland city. I wish to go strongly on record as disagreeing with the district engineer, Col. Craighill, in his report that the project had no economic value.

I deeply regret my inability to appear before you and speak in favor of this project, which has been so dear to the hearts of so many of us for so many years.

Mr. A. B. Sutherland, who will present this letter in my absence, has unlimited data to prove to you that the project is economical and practicable.

The city of Lawrence has pledged itself to build and maintain piers and wharves on the river front.

The State of Massachusetts has appropriated \$1,000,000 as an evidence of good faith and belief in the project.

At a most conservative estimate, the saving on raw material alone would be in excess of the required interest on \$10,000,000.

I wish to impress on the members of your board that I thoroughly believe in this project and that Lawrence is a unit and squarely behind it.

It is a project of merit and is devoid of engineering objections.

I wish to make my strongest plea for your thoughtful consideration of the arguments presented by Mr. Sutherland and that you will receive them with an open mind, unprejudiced by the adverse report of your colleague, whom we hold in the highest esteem, but with whom we fail to agree.

Yours, very respectfully,

JOHN J. HURLEY,
Mayor.

The BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

STATEMENT OF THE LOWELL BOARD OF TRADE.

Gentlemen, for a number of years the residents of the Merrimack Valley have been urging that suitable plans be adopted for making the river navigable. With that in view your engineers have made a critical study of the situation and have reported their findings. In the meantime the valley residents have endeavored to furnish statistics to prove that the project is a good business venture. These statistics we still adhere to, except that in the progress of the past two years we are able to make considerable additions to their impressiveness. In Lowell, for instance, the total freight tonnage handled by the railroads has increased tremendously, the Boston & Maine system alone receiving a monthly gain in its freight receipts of about \$40,000. We believe, therefore, that all the figures presented to your engineer as representing the tonnage of the valley are capable of decided expansion, and that the growth of this past two years may safely be taken as indicative of the future of the cities of the Merrimack Valley.

The Lowell Board of Trade has made an honest endeavor to present the Lowell argument based on facts and not on fancies. We have no desire to urge upon the Federal or State governments anything that is unreasonable and we believe thoroughly in the policy which will force the Merrimack Valley to prove its case and rest the decision on its merits. We do believe, however, that the Merrimack River possesses unusual elements of merit for development as a navigable stream by the Federal Government. In the search for information the Lowell Board of Trade has collected the following facts which principally govern our own attitude toward the project.

On March 24, 1915, the manufacturers of Lowell were invited to meet and discuss the river project. Practically all the mill agents in Lowell responded, and with them came Mr. Hiram F. Mills, engineer for the locks and canals. Mr. Mills acted as spokesman for those present and read a document which he subsequently filed with Col. Craighill. He frankly opposed the project and presented his reasons. At the conclusion of his presentation of the case he was asked if, in his opinion, the river channel would affect the present water power at Lowell. He replied that it would not. He further stated that the river channel and a suitable connection of its terminus with the manufacturing centers in Lowell could be easily accomplished. Basing our opinions on these two principal factors, for we had no desire to impair the facilities with which our existing industries were operating, we have presented to your engineer an accumulation of data bearing on the commercial value of the Merrimack River channel. In his report on these Col. Craighill takes the position that the river channel would not be valuable in a business way; yet when he met a committee of Lowell men on August 5, 1915, he assured us that he had no hesitation in saying to us that the channel would be worth \$10,000,000 to the valley cities and towns. The whole question seems to hinge on just what is the valid interest of the Federal Government in this project. Our answer to that is the immense total of commerce in the Merrimack Valley, the existence of several large cities and many thriving towns, and the very evident tendency of our section to expand commercially. Furthermore, we argue that the Federal Government policy has led us to expect a favorable view of the Merrimack Valley possibilities, inasmuch as millions of dollars have been expended on what seem to us to be projects of far less merit and importance. If the Federal Government is interested in many of its present river projects, it surely should be in the Merrimack.

We wish to point out to your board the fact that the only person in the entire Merrimack Valley to offer opposition in public to the project is Mr. Hiram F. Mills, the water-power engineer for the locks and canals and Essex Co. It is not the fact that he is open in his opposition that we wish to emphasize, for we have welcomed his tangible evidence of interest in the plans. But he stated to Col. Craighill at the public hearing that he voiced the sentiments of every mill agent and mill treasurer in Lowell in declaring that the channel is not wanted. We wish, in rebuttal, to remind you that at the very hearing at which Mr. Mills made this assertion testimony in behalf of the river project was given by Mr. F. A. Flather, treasurer of the Boott Mills, Mr. A. D. Milliken, agent of the Hamilton Manufacturing Co., Mr. F. A. Bowen, agent of the Appleton Co., as well as by Hon. Butler Ames, head of the Heinze Electric Co. and Wamesit Power Co., George S. Motley, president of the Lowell Gas Light Co., and others. Mr. Mills has also assured us that it is his opinion that the river development is sure to come some time in the future, and we set that against the assertion of Col. Craighill that the mill properties along the river bank would be unable to meet the requirements for water-frontage facilities without extreme expense. Mr. Mills knows these situations perfectly, and yet he sees a river channel as certain at a future time. We might further declare that the Lowell mills have considered definite plans for providing water-front facilities to serve their needs. However, it is certainly true that in any public hearing on the river project, whether given by United States, State, or commission authorities, Mr. Mills is the only person to offer any argument in opposition; and the only mill agents or treasurers to say anything have spoken in favor of the project.

Since our last presentation of arguments for the river channel, events have conspired to prove the need for additional transportation facilities in the Merrimack Valley. Embargoes have prevented freight movements, and delays that have seriously hampered Lowell industries have been constant because of the inability of the railroads to furnish needed facilities. The possession of the alternative of a river channel would have been tremendously helpful. It would have eliminated much of the congestion and delays.

Many other points can be emphasized to meet Col. Craighill's findings, such as the fact that the cities along the river have taken steps to guarantee municipal terminal facilities; that the Lowell mills are actually depending to-day on water power only to about one-third of their entire power needs; that the change in the system of receiving coal, so far as Lowell is concerned, would not be inconvenient, as the power plants are, generally speaking, located on the water front; that it is practically certain that the river channel would serve to cause reductions in freight rates by the railroads, although the Boston & Maine is on record as declaring that this will not necessarily be so; that a movement is already on foot in our State to require the removal of objectionable sewage from the river; that the statistics and estimates which we have offered have been based on actual information, while those submitted by Mr. Mills, our only opponent, have been admittedly assumptions.

We have noted with interest the recommendations made by Col. Abbot in transmitting Col. Craighill's report to the War Department. Col. Abbot points out the fact that there is, at least, a proportional interest on the part of the United States Government. We would like to see that proportion scientifically worked out, and that without relinquishing our original position that the Merrimack River is important enough for decisive Federal action.

The Merrimack River is a big stream. It is wide, and many miles of it are deep enough now to transport sizable vessels. It winds through cities whose commercial importance, taken as a whole, can not be matched in any 40-mile strip of river in this country, and these cities are growing beyond the possibilities of being served by the present railroad facilities or any they are likely to provide. We do not believe, therefore, that we are asking anything unreasonable and we thoroughly believe that we are entirely consistent in urging that further examination be made of this project. Having confidence in the honesty of our figures and knowing that our purpose is solely to assist in solving this problem properly, we feel assured that your board will grant our request and cooperate with us to the fullest extent.

For the Lowell Board of Trade:

ROBERT F. MARDEN, *President.*

To the BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

STATEMENT OF INTERESTED PARTIES.

We are impressed with the fact that an adverse report from Col. Craighill is a handicap which we must contend against, but considering that report in the light of the evidence which has been presented and which is before the full board for consideration, we feel it should not be an insurmountable obstacle; and considering, further, the fact that under the jurisdiction of the Commonwealth of Massachusetts a most thorough investigation of this project has been conducted and conclusions have been arrived at, based upon facts which are incontrovertible, it does not seem that the adverse report of any one man, no matter who he may be, should be accepted without every man on this honorable board of appeal weighing the evidence carefully.

The Commonwealth of Massachusetts has arrived at conclusions. It feels sure of its grounds. It has shown its faith in the same by a substantial appropriation. Its investigations have been most thorough. The labor of many skillful men has been expended for years past in gathering data which are accurate and reliable and uncontradicted to prove to you that the Merrimack River is practically the only stream in the world that has a commerce of hundreds of millions annually already developed and untold millions to be developed which has been absolutely neglected by the General Government so far as navigation is concerned and left entirely to its own salvation. It can challenge the world to point out another river in either the Eastern or Western Hemisphere that has the volume of water, the population on its banks, the developed industries and developed commerce, and the natural resources and tremendous possibilities for future expansion, and yet (although it has contributed generously toward the development of rivers and harbors in all parts of this country of infinitely less importance) there has been no reciprocation in its behalf.

Notwithstanding this adverse report, the people of Massachusetts know what they have in the Merrimack River and they know what their rights are. Until recent years they have been asleep to their rights, they have gone along industriously with their own developments, and have been prospering slowly without lifting their heads to take a wider survey and to say to the General Government, "Here we may be able to get along without you, but we will make much more rapid strides with your help. We have helped others for decades by our contributions toward the General Government. Now come and help us and we will return it one hundredfold by the acceleration we will get by the help which it is the function of the General Government to give us." We mean business now and we do not propose, after having satisfied ourselves by data which can not be questioned that we have the one river of magnitude in the world that has been neglected, that this neglect shall continue, and until we have exhausted every remedy to have this wrong righted. An adverse report of no one man should block a great project that is believed in by the entire body of a great State, with the exception of a few having selfish interests to the contrary, a project which will be of lasting benefit to a dense population in the Merrimack Valley and the means of creating their shores into commercial ports of national and world importance.

We trust that the hearing in this appeal will interest this board enough to cause every man on this board of appeal to read the evidence and try to discover for himself in the light of the evidence how an adverse report could be made based on such evidence. With the evidence before you each has the same opportunity as had Col. Craighill to arrive at an independent conclusion. The evidence has been gathered after great labor and diligence and has the prestige and dignity of having been gathered under the jurisdiction of a commission appointed by the great and general court of Massachusetts, who are prepared to vouch for its accuracy, and with proper regard for the comity and courtesy due to the State of Massachusetts it should not be pushed aside lightly. In an appeal to the full bench of our Supreme Court of Massachusetts the decision of the lower court undoubtedly bears weight, but when the appeal goes up on the whole evidence that evidence is read and considered carefully by each of the supreme justices, and if they find the decision is not justified by the evidence there is no hesitation on their part to set it aside. Should we not expect the same from this board? In a case I recently argued before our supreme court, on which I went up on the whole record from an adverse verdict of a jury caused by a prejudiced and unfair charge of the trial justice, after

reviewing the evidence and commenting on the charge excepted to, the supreme court ended by saying, "The great preponderance of the evidence was the other way; that is enough," and handed down a decision in my favor. May we not hope that after this board has carefully read and considered the record of the evidence presented to them in this case and then compares this with the adverse report that your board will say, in the words of our supreme justices, "The great preponderance of the evidence is the other way; that is enough."

The Merrimack Valley is to-day hampered, annoyed, and retarded by lack of freight facilities. We have reached a certain growth; we have the natural features to enable us to expand away beyond this, but we are surrounded by a steel band; we must ask you to burst it for us, so we may expand. We are fed by artificial means through congested areas, narrow and limited rails bring in and take out our commodities by the spoonful, when nature intended it should be shoveled to us through the great artery which God created to nourish and develop our fruitful valley. No other Government in the world would fail to help out nature that has been so lavish in giving us a broad expansive river for the development of our country. No other nation would drive us to the narrow byways for trade when there was a broad, expansive highway to our door which needed but a little top dressing to make it perfect. We feel that prosperity is here to stay. The foolish and sad struggle across the ocean has impoverished Europe. Our securities which they held and on which we were paying millions in coupons and dividends are now returned to us, and in addition we have all their bonds we can digest. All the dividends and interest on their bonds and ours will now be enjoyed by us, and the money kept in this country. The Europeans will be our slaves for years to come. As a result, we must prosper and expand and all shackles which prevent us from doing so must be broken.

We look to you gentlemen to break these shackles for us in the Merrimack Valley, to give the finishing touches to a noble river, so that not only the inhabitants on its banks, but the whole United States may have the full benefit of its great commercial—not possibilities but certainties.

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

STATEMENT OF MR. W. F. WILLIAMS.

Before coming to a consideration of the project in its relation to the commercial requirements of the communities to be benefited, I think it is well to devote a few minutes to a consideration of the fundamental principles involved in the transportation problem that confronts Massachusetts.

The recent embargo on rail freight shows the present inability of New England railroads to handle a very material increase in their normal business, and only for the relief afforded by a diversion of large amounts of freight to water points like Providence, Fall River, and New Bedford was a situation avoided that would have seriously crippled the manufacturing industries of New England.

It is becoming daily more apparent that water routes must be utilized to a greater extent than ever before for the carriage of bulky freight, and that distribution in much of New England can be better and more economically made from the coast inward than from the interior outward.

The greater part of the manufacturing centers in Massachusetts are on water routes. That was the reason of their location, and in most cases it antedates the coming of the railroad. It is also largely the reason for the high cost of rail carriage in Massachusetts under present methods of operation.

Some years ago Mr. Mellen made the statement that from a railroad point of view New England was simply a great freight yard, and it covers the situation in a nutshell. It is a great problem in economic distribution in which the natural water terminals must be utilized in an ever-increasing degree.

Mr. Mellen showed his appreciation of this situation when he secured control of practically every established water route east of New York City. The water lines are the salvation of the present freight situation in Massachusetts, and the threat recently made by an official of the New Haven Railroad at a hearing before the Interstate Commerce Commission, that the railroad would increase its facilities and do all the business by rail that is now performed by the Sound

Lines, if they were forced to give up their control of these lines under the terms of the Panama act, is simply ludicrous in its impotency.

A very large amount of freight to and from Lowell and Lawrence is shipped via the New Bedford boat line. Ordinarily the business of this line is cared for by two boats, one each way a day. At times this winter and spring it has required four boats to handle this business, and they could have had more if they had had the boats and the wharf room.

The great demand for water carriers, as a result of the war in Europe, has seriously reduced the capacity of the coastwise commerce and thrown a greater burden upon the railroads, but this will soon be regulated, and in a way it may be a beneficial hardship if it opens the eyes of shippers to the value of water routes.

It is most unfortunate that the railroads have secured such a control over the water lines, because they have operated them to protect rail rates rather than to develop the most rapid and economical transportation system, as evidenced by the fact that independent water lines have found it impossible to exist wherever interchange of business with the railroad was essential to their success.

A strictly coastwise express service has yet to be tried out, but it is bound to come and will undoubtedly solve some of the present transportation troubles.

The lack of any attempt to standardize harbor and river improvements has impaired their value and in many instances it has been the cause of inadequate utilization of large expenditures of money. It is also true that lack of local cooperation has been responsible to some extent for these failures.

A harbor or river improvement must fit existing water carriers adapted to the requirements of the community to be served, or it will fail of its object almost as surely as a narrow gauge railroad in a territory where all of the connections are of the standard gauge. Experience has shown that it is extremely difficult to build up a marine service on a restricted draft; as a matter of fact, it must be a local venture.

The tendency of water carriers in the coastwise trade as well as in foreign commerce is to deeper draft and larger tonnage. This is disastrous both to the shoal harbors and the small shippers, and it is to be hoped that the Federal Government will lend its aid to several projects now under consideration, such as the improvement of the Connecticut River and the Taunton River, that are designed to meet the dimensions of the New York Barge Canal. The carrying out of these improvements will lead to the creation of shoal draft carriers of some seagoing qualities that in time would add greatly to the commercial value of many of our small harbors.

There should be a greater effort to coordinate harbor improvements with commercial requirements and developments.

Coming now to a consideration of the project for the improvement of the Merrimack River, its status at present appears to be that Col. Craighill has made a survey and an estimate of the cost of providing a channel 200 feet wide and 18 feet deep to Ward Hill, Haverhill, and the Merrimack Valley Waterway Board has made a survey and estimate of the cost of a canalization of the river from this point to Lowell on the same basis of depth and width. The details of the latter investigation have been most clearly set forth in the printed report of the board with which you are all familiar. Col. Craighill's report, however, has not been printed and is not therefore open to discussion in detail, although certain features are more or less matters of common knowledge and I understand can be properly referred to at this hearing. The most important question that is raised by the report, and which I assume is the basis of this hearing, is the conclusion of Col. Craighill that the benefits to be secured by the improvement are not commensurate with the cost.

The cost of the improvement from the sea to Ward Hill, Haverhill, as estimated by Col. Craighill, will be about \$8,000,000 for a dredged channel 200 feet wide and 18 feet deep at mean low water, or \$2,750,000 for a dam at the Lions Mouth with a dredged channel above the dam and to the sea of the above dimensions.

The cost of the improvement above Ward Hill to Hunts Falls in Lowell, as estimated by the Merrimack Valley Waterway Board, will be \$5,443,600, but this provides for a turning basin, power plant, and locks at Ward Hill, whereas all but the turning basin will be eliminated by the construction of a dam at the Lions Mouth. Therefore, a deduction of \$1,117,000 may be made in the estimate

of the cost above Haverhill, which will make the cost of the combined projects \$7,076,600 as per the following details:

Estimated cost by waterway board—Ward Hill, Haverhill, to Hunts Falls, Lowell.

Locks, turning basin, and power plant at Ward Hill-----	\$807, 000
Dam at Kimballs Island-----	310, 000
Lock and channel at Lawrence-----	921, 000
Channel, Lawrence to Lowell-----	3, 405, 600
	5, 443, 600
Estimated cost of dam at the Lions Mouth and dredging channel from Newburyport to Ward Hill, by Col. Craighill-----	2, 750, 000
Total -----	8, 193, 600
Deduct for locks and dam at Ward Hill-----	1, 117, 000
Net total of combined estimates-----	7, 076, 600

Col. Craighill further estimates that it may cost \$3,000,000 to provide terminals, pay damages and change bridges, and thereby arrives at the conclusion that the total cost of the project will be \$10,000,000, upon which there should be an annual return in the way of an actual saving in freight charges equivalent to 4 per cent, plus an estimated maintenance cost of \$100,000, or a total of \$500,000. After giving some consideration to the probable saving in freight charges he has evidently arrived at the conclusion that it will not amount to \$500,000 per year.

Before discussing this question further it may be as well to briefly refer to two matters covered in the report and discussed at the later hearings from which I learn that Col. Craighill is somewhat concerned that a dam at the Lions Mouth may seriously affect the maintenance of the present entrance between the jetties at the mouth of the river, and also that the pooling of water carrying so much sewage may produce a very unsanitary situation above the dam.

Of course, the tidal action of the river will be considerably reduced, but the fresh water discharge will continue for whatever it may be worth. As a matter of fact, the ultimate effect at the jetties is a speculation and one man's guess is about as good as another's. It may be well to bear in mind that there are some very good harbors on the Massachusetts coast without rivers. The construction of a dam at the Lions Mouth will probably change to some extent the conditions at the entrance; but I do not think it necessarily follows that the efficiency of the jetties will be seriously impaired, or that the difficulties of the problem will be increased. On the contrary, I am not so sure but that they may be improved.

The sewage question is wholly independent of the commercial development of the river, and whether a dam is or is not built there will come a time when the sewage will either be taken out or so treated that it will become innocuous. Therefore I do not think you need concern yourselves about that phase of the situation, and we come then to the real issue as to whether or not the probable returns upon the investment will justify it from a commercial point of view.

I appreciate the desire of the engineers to be able to show that the saving in freight rates that will result from contemplated river and harbor improvements will at least amount to 4 per cent interest and annual maintenance charges upon the estimated cost of the project. I venture to say, however, that very few river and harbor improvements in the past 25 years could meet such a requirement at the time of their adoption.

As a matter of fact, it is only when dealing with communities removed from water transportation like the locality under consideration that an actual and substantial saving on rates can be shown, because rail rates to water points have always been based upon the water rate to that point, in proportion, of course, to its water facilities. For instance, New Bedford has always had water rates on all commodities that could possibly come by water, notwithstanding that for years its channel depth would not admit of water shipment by the usual carriers in some of those commodities. Therefore, if New Bedford had been obliged to show a saving on prospective inward and outward business, based upon the existing rail and water rates, equivalent to 4 per cent upon the cost of the project just completed as a prerequisite to securing the

appropriation, it would never have got it. But it can be shown beyond a question of doubt that the returns from the Federal investments in New Bedford Harbor have been far in excess of the entire outlay. Of course there has been a saving in rates, but the benefits are widespread and sometimes in directions that were not anticipated when the project was exploited. As an example, New Bedford will soon have the largest public warehouse capacity in the State, outside of Boston, but it has taken several years to bring about this development, and it has come entirely as the result of the combination of rail and water transportation facilities. It is also interesting to note at this time that the latest addition to the warehouse equipment will have a capacity of 500,000 bales of cotton, and it is to be built by William Whitman, who is also a large mill owner in Lawrence. The warehouse will not be limited to cotton, but the bale of cotton is used as a unit of measure because it is the most comprehensive standard in a textile center.

Now, there are those who argue that all such developments are the result of subtraction, that every profit means a loss to some one, and that if water transportation is given to a community that hasn't it, then some existing route or locality must lose its equivalent. The argument might be good if we have reached the limit of our growth; otherwise it will lead to the serious economic calamity of stagnation or over-centralization of industrial effort. There seems to be a suspicion that in some way the benefits derived from the proposed improvement of the Merrimack River will be fully offset by losses in other directions, but you can easily satisfy yourselves that this is a fallacy if you will study the commercial development of cities like Providence, Fall River, and New Bedford, where the Federal Government has spent considerable sums of money to secure channel depths that fit the present requirements of coastwise commerce.

It takes years to secure these improvements which provide ample opportunity for the readjustment of interests that might be adversely affected if the changes took place in a short space of time.

Taking up the discussion of commodities that will be most affected by direct water transportation, I want to say a few words about coal and cotton, as they naturally have received the most attention by the parties interested in this improvement, because they are used in large quantities by their communities.

It is axiomatic that a water point with adequate depth gets its coal at water rates, because no railroad can compete with water carriage, and this would be true of cotton were it not for certain artificial conditions that are destined to be changed in the near future.

Coal.—It appears that the rate on steam coal to Lowell and Lawrence is normally 85 cents per ton more than to Salem or Boston, and the added cost to Haverhill is about 60 cents per ton, so that the issue in arriving at the value of the improvement seems to hinge upon how much of this difference can be saved if coal could be delivered direct by water to the cities named.

There seems to be a general agreement that the annual consumption of coal for power on the Merrimack River to Lowell may be taken at 1,200,000 tons. The saving is variously estimated from 25 cents to 50 cents a ton on shipments varying from 50 per cent to 100 per cent of the total consumption. In my opinion the quantity shipped by water will depend entirely upon the facilities. If they are adequate in the sense that they can be utilized by existing coal carriers, then it will all be shipped by water. This is the experience of all ports such as Providence, Fall River, New Bedford, and Boston, where the draft and discharging facilities are adequate. At present there is a considerable tonnage available on a 17-foot draft, but over a million tons of freight annually is an attractive proposition, and some one will be sure to want to carry it.

The rate is more difficult to forecast, but I can not see why it should be more to the mouth of the river than to Portland, which, I understand, has a rate only 10 to 15 cents more than to Boston. The present rate to Newburyport is no basis for comparison, as the existing draft is not sufficient and therefore the tonnage is small. Coal rates exhibit peculiar inconsistencies; for instance, they are about the same to Boston as to Providence, Fall River, and New Bedford, notwithstanding the greater distance to Boston. In view of the size of the Merrimack River tonnage it would not be at all surprising if the rate to the mouth of the river should be the same as to Boston, and in no event will it be more than the rate to Portland.

I note that in one communication Mr. Mills makes the cost to Newburyport 33 cents more than to Boston and 10 cents more per ton in the mill yard by

the river than by rail from Boston. In another statement he estimates the cost to Hunts Falls at 20 cents more per ton than to Salem and assumes the cost from this point to the mill yard at 60 cents per ton, based upon the cost of hauling a very small quantity by motor truck, and arrives at a net saving of 5 cents per ton by the river route. In both estimates the principal item of cost is the delivery to the mill from Hunts Falls, while the rest of the cost is based entirely upon distance, which, as I have already shown, does not control the rates to principal water points.

Mr. Mills places the present cost of unloading and delivering coal to the mills in Lowell at 56 cents per ton and applies the same cost at Hunts Falls. I have very little doubt but what this price would be materially lowered by the competition that would prevail with a public terminal and generally broader market conditions for this commodity.

In my opinion, a reasonable estimate of the saving in cost of soft coal by all water to Lowell over the present water-and-rail cost will be 30 cents per ton on the minimum mill-yard rate of 85 cents, but the testimony shows that this low rate is only enjoyed by those mills that have tracks to their yards, and to all other consumers the difference in cost is nearer \$1 per ton. Therefore to this class the saving would be greater than 30 cents per ton. The saving to Newburyport, Amesbury, Haverhill, and a part of Lawrence would also average more per ton, so that it is not unreasonable to assume a net saving on soft coal of at least 40 cents per ton. Now it will also be possible to make a saving on hard coal because it can come cheaper by water than by rail, although it may take longer to establish the change; but some allowance should be made for this business in your consideration of the benefits to follow the proposed improvement.

Cotton.—As I have already stated, the routing of cotton to New England is controlled by purely artificial conditions that make it very difficult to show by a comparison of rates any substantial advantage in favor of water routes, although there is a large amount of cotton shipped to Massachusetts by water and it is steadily growing.

The shipment of cotton to Massachusetts mills has been almost if not entirely controlled by the railroads as the result of certain peculiarities of the business as conducted in this State: First, all cotton except the low grades is bought on samples and the mill insists upon receiving the actual bale from which the sample was drawn; this naturally results in the shipment of small lots and from many different points. Second, the shipper pays the freight, and as he is only concerned in his own shipment, which is generally in small lots and always starts from a railroad point, the routing is left to the railroad company. Therefore for many years the rate on cotton to the mill centers in Massachusetts, including even New Bedford and Fall River, has been the same, whether it came all rail or all water; but there is no direct water route to either of these points, and all cotton received by water comes by the way of the Sound lines from New York City. However, in spite of this unnatural diversion, the receipts of cotton by water at New Bedford have steadily increased until this year, when there has been a considerable increase by rail as a result of the foreign demand for steam vessels.

During the cotton-shipping season of 1914 and 1915 New Bedford received for its own mills 92,698 bales by water and 227,776 bales by rail, and for reshipment to interior points it received by water 148,975 bales.

The rate on cotton from New Orleans to New Bedford is 33 cents per 100 pounds and 35 cents to Portland, but it is 50 cents per 100 pounds to Lawrence, as I am informed; but whether this is all rail or part rail by way of New Bedford or Portland I have not been able to learn. On the face of the figures there appears to be a difference of 17 cents in favor of New Bedford and 15 cents in favor of Portland, and certainly some portion of it could be saved to Lawrence and Lowell if there was navigation on the river. If it were only 5 cents per hundredweight it would amount to 25 cents per bale, which is equivalent to \$125,000 per year on the cotton used by these two cities.

The present peculiar conditions controlling the shipment of cotton to Massachusetts will no doubt be changed in the near future. It is a singular fact that there is no direct water line between New Orleans or Galveston and any point east of New York when it is recalled that more than 50 per cent of the cotton raised in this country is shipped out of those two ports. Mill managers are learning that water shipment is much more rapid than by rail and they

are already requiring shippers to route cotton by water lines. New Orleans has recently completed a very extensive cotton warehouse system which will make it possible to group for shipment the small New England lots, and eventually this will bring about direct water delivery to Massachusetts ports with a saving not only in the expense and loss now due to the unnecessary transshipment in New York Harbor, but in freight charges as well.

The saving in time that can be accomplished by shipping by water lines as compared with railroads is not properly appreciated, and while it may be difficult to express the value of this feature in terms of percentage upon cost it is nevertheless deserving of your consideration.

Lumber.—I find that apparently very little has been said in detail regarding the saving to be made on the shipment of lumber by water, although the estimated receipts at Lawrence, Lowell, and Haverhill are quite large.

It is safe to assume that if the Merrimack River were navigable, Lowell, Lawrence, and Haverhill would import by water on about the same basis as New Bedford and Fall River, whose combined population is a little more than two-thirds that of the three cities on the Merrimack River.

The report of the Chief Engineer of the War Department for 1914 gives the lumber receipts for New Bedford as 10,329,514 feet b. m., and 4,997,900 shingles, and for Fall River, 14,113,065 feet b. m. and 238,750 shingles. On the basis of population, the receipts of lumber for Lowell, Lawrence, and Haverhill should be about 32,000,000 feet b. m. and about 8,000,000 shingles. A saving of \$2 per thousand in freight rate should be made on the lumber and 50 cents per thousand on the shingles. These commodities have also the advantage of a considerable tonnage of moderate draft vessels, but as they are mostly of the sailing type, there would be the long tow up the river to add to the rates secured by New Bedford and Fall River.

There would also be the consequential reduction on rail shipments of lumber, which it is not easy to reduce to an expression in dollars per unit of measure, but it will surely amount to a large sum of money.

Something has been said at the various hearings in regard to the probable stoppage of navigation on account of the river freezing in the winter, and I understand that it was generally agreed that this may cover a period of two months a year throughout a period of years. While this is a factor to be considered by the shipper, it sounds worse than it really is, for the reason that it comes at a period when water shipments are more or less uncertain to any water point in Massachusetts. It certainly is no bar to the utilization of water routes, as is well shown by the highly successful operation of navigation on the Great Lakes and northern canal systems that are open only eight months out of the year.

Conclusions.—I can see no reason for doubting that an adequate development of the Merrimack River will create a water-borne commerce comparable with that of New Bedford and Fall River, as the character of the commerce of these great manufacturing centers must be very much the same, although the present traffic methods are very different. Therefore, on the basis of the comparison suggested, the commerce of the three cities on the Merrimack River should amount to nearly 4,000,000 tons annually, and there can be no doubt but what the annual saving upon this business would soon repay the cost of the proposed improvements.

Apparently, Col. Craighill has made the visible saving in freight charges the critical test of the commercial success of this project, and has thereupon based his estimate of the probable returns entirely upon difference in rail and water rates as they now exist, irrespective of the fact that they are arbitrarily adjusted by one rate-making power, which is the railroad.

In my opinion, comparison with well-established water terminal points is the most safe basis upon which to base the probable results of an improvement of this character. The results actually secured in the harbors of Massachusetts that already have adequate facilities for the commerce of to-day is safe and sound evidence of what can be done. I maintain that the most important question for you to consider in connection with this development is not the difference in freight rates, but whether or not this project adequately meets the requirements of the commerce that it is expected to serve.

I am convinced from my study of all the testimony before you in this matter and from my own knowledge of the freight conditions in Massachusetts that the following estimate of saving in rates on the three principal commodities, viz,

coal, cotton, and lumber, if water transportation is granted these communities is conservative:

1,000,000 tons of coal, at 40 cents_____	\$400, 000
500,000 bales of cotton, at 25 cents_____	125, 000
32,000,000 feet b. m. lumber, at \$2 per thousand_____	64, 000
8,000,000 shingles, at 50 cents per thousand_____	4, 000
Total _____	593, 000

I now want to direct your attention to the statistics of the improvements of the few harbors that I have referred to, and also of the Connecticut River.

Providence (population, 1910, 224,326) :

Expenditures by the Federal Government prior to 1873_____	\$59, 000. 00
1882 project, completed in 1895_____	632, 500. 00
1892 project, completed to 1908_____	483, 200. 00
1902 project, cost up to 1914_____	684, 779. 00
Existing projects, estimated to cost_____	1, 571, 600. 00
To be spent by State and city_____	2, 000, 000. 00
	5, 431, 080. 00

Total spent by Federal Government to the end of the fiscal year 1914_____	2, 559, 010. 48
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Freight traffic for year 1913, 4,539,805 tons, which includes 520,757 tons for the Pawtucket River.

The original depth of the Providence River at its shoalest point was 4.5 feet at low water, and the depth that will be secured by the existing projects is 30 feet at mean low water.

New Bedford (population, 1910, 96,652) :

Total spent by Federal Government on all projects to 1914__	\$694, 801. 45
Freight traffic in 1913, 1,491,046 tons, worth_____	46, 360, 645. 43

Original depth in harbor was 12.5 feet at mean low water. Present depth 25 feet at mean low water.

Fall River (population, 1910, 119,295) :

Total spent by Federal Government on all projects_____	\$350, 232. 02
Freight traffic in 1913 was 1,286,077 tons, worth_____	50, 714, 675. 77

Present depth 25 feet at mean low water.

Connecticut River.—Quotations from the report to the Chief of Engineers by Maj. G. B. Pillsbury, Corps of Engineers, U. S. A.

Aggregate population, Springfield, Holyoke, Chicopee, and West Springfield by the census of 1910 was 181,281. The inward and outward freight of these cities and towns for 1912 was 2,977,900 tons. Maj. Pillsbury estimated the water traffic per annum would be 600,000 tons of coal and 100,000 tons of general freight, making a total of 700,000 tons. He says in his report that if suitable draws are provided in existing bridges a steamboat service to New York may be expected. The benefit to be derived will be a more prompt delivery rather than a reduction in cost of transportation. This advantage is very material, as shown by the use of steamboat facilities on the lower river, where the rates are the same by rail and by boat. He further says that the rate by water on coal to Hartford is given as 60 cents per ton, and he thinks that with an adequate channel the charge for the further haul to Springfield and Holyoke, including the passage of one or more locks, should not exceed 15 cents per ton. This distance is about 30 miles. He estimated that the return on the 700,000 tons of freight annually would be from \$200,000 to \$300,000.

The estimated cost of the project is \$1,870,000, without the dam at Enfield, which is to be built by private parties at a probable cost of \$2,080,000.

Maj. Pillsbury states under the heading of cooperation: "I concede it to be one of the functions of the present report to suggest and recommend a distribution of the cost of improvement which will be equitable in view of the benefits conferred." And further on he says: "I am constrained to the opinion, therefore, that it is but equitable that the General Government bear the entire cost of the interstate improvement of the main river channel and that the cooperation of the State and of local interests be directed to the construction of municipally controlled terminals, branch channels thereto and harbor basins, and other

local facilities for navigation, the cost of which, if adequately executed, will be in no inconsiderable ratio to the cost of the main channel."

WILLIAM F. WILLIAMS,
Chief Engineer, Harbor and Land Commission,
State of Massachusetts.

The BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

Statistics relating to cities and towns on the Merrimack River in Massachusetts.

Total population-----	307, 540
Total value of assessed estates, April 1, 1913-----	\$262, 710, 204
Total number of establishments-----	814
Total capital invested-----	\$188, 152, 336

This represents about 53.1 per cent of the capital invested in metropolitan Boston (including Boston and 39 other cities and towns) and about 14.4 per cent of that invested in the whole State.

Total value of stock and material used-----	\$116, 870, 360
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This represents about 36.5 per cent of that of metropolitan Boston and about 12.6 per cent of that of the whole State.

Total amount of wages paid during the year-----	\$42, 004, 459
Total number of wage earners employed during year-----	85, 069
Total value of product-----	\$196, 595, 077

This represents about 36.1 per cent of the total value of product of metropolitan Boston and about 12.4 per cent of that of the whole State.

LETTER OF THE SECRETARY OF THE LAWRENCE CHAMBER OF COMMERCE.

LAWRENCE, MASS., *May 20, 1916.*

GENTLEMEN: We of Lawrence, in conjunction with representatives of our sister cities of the Merrimack Valley, come to you once more with our petition for help to make the Merrimack River navigable from Lowell to the sea.

When we consider projects in the South and West which have received your favorable consideration and on which vast sums of money have been and are being spent, we ask ourselves in what manner have we failed in our presentation of the merits of this project, that up to the present time we have not succeeded in enlisting the assistance of the Federal Government in a project with such obvious merit as this presents.

We have this river, serving a dozen populous and prosperous communities, in one of the most thickly settled and wealthy Commonwealths of this United States. The banks of this river are lined with industries. The channel of this river is always well-supplied with water at every season of the year. The ice interference on the river is negligible and could be easily handled. The traffic is already developed and awaiting movement.

The communities which line this river are, one and all of them, suffering from inadequate transportation service by rail carriers.

The district engineer reports no engineering obstacle, but fails to recognize any economic value in the project.

Such masses of data have already been presented, both at this hearing and at previous hearings, and in previous reports and petitions, that it would be useless for me to add further to their volume, and I shall confine myself wholly to the citation of strictly local conditions known to me personally to exist in our own city of Lawrence, viewed strictly from an economic and transportation point of view.

Mr. John A. Bernhard, president of the Alabama and New Orleans Transportation Co., New Orleans, La., and at present engaged in promoting a \$5,000,000 barge line between St. Paul and New Orleans, is authority for the statement that coal can be profitably handled between Norfolk and Boston for 35 cents a ton, and to Portland for not over 45 cents.

The Lawrence Gas. Co. now use more than 40,000 tons of coal, on which they pay

80 cents freight Philadelphia to Boston, 608 miles.
85 cents freight Boston to Lawrence, 26 miles.
18 cents handling in Boston.
3 cents weighing in Boston.

\$1. 86

With a navigable Merrimack there might be an additional 5-cent water freight to Lawrence, but the rail-haul charge of 85 cents would be wiped out, thereby effecting a saving of 80 cents and doing away with the expense of 21 cents handling in Boston.

With coal brought to Lawrence in boats and the resultant saving, steps would surely be taken to establish pockets and unloading facilities on the banks of the river.

A careful canvass has been made of the larger firms, which discloses a much larger coal tonnage than shown by the Boston & Maine official reports for 1914, which formed the basis of Mr. S. F. Sherman's figures of last year.

Following is a statement of coal used in 1915 by 22 of our larger industries:

	Tons.		Tons.
American Woolen Co_____	170,000	Walworth Brothers_____	3,000
Pacific Mills_____	125,000	E. Frank Lewis_____	3,000
Everett Mills_____	70,000	Archibald Wheel Co_____	1,000
Arlington Mills_____	75,000	Emerson Mfg. Co_____	200
Pemberton Co_____	8,000	Wright Mfg. Co_____	500
Plymouth Mills_____	5,000	Mills Machine Co_____	200
Brightwood Mfg. Co_____	5,000	J. H. Horne & Sons Co_____	300
Tyer Rubber Co_____	3,000	M. T. Stevens & Sons Co_____	2,000
Smith & Dove Mfg. Co_____	5,000	United States Worsted Co_____	5,000
Champion-International Co_____	10,000	Lawrence Gas Co_____	40,000
Merrimac Paper Co_____	2,000		
Munroe Felt & Paper Co_____	2,000		535,200

Even at 80 cents a ton saving, leaving the 21 cents a ton to take care of the handling in Lawrence, this would mean a saving of \$420,000 on coal alone. This is an extremely conservative estimate, and takes no account of the tremendous tonnage of cotton, wool, lumber, pig iron, pulp wood, cement and lime, sand, granite, brick, oil, etc., which could be profitably handled by boat, if the river were made navigable.

When one takes cognizance of the fact that the tonnage for 1916 has been nearly, if not quite, double that of 1915, the figures and consequent saving become enormous.

But one factor is overlooked, which contributes very largely to the cost of the present system of rail transportation, viz, the car demurrage paid the railroads on outstanding cars of coal. During the past winter thousands of dollars were paid to the Boston & Maine Railroad in Lawrence alone on coal which was frozen in the cars and difficult to handle. This money was thrown away, as it did not fully compensate the carriers for the delay to the cars and the consequent slowing up of business all along their line, which involved much extra switching and expense, besides the regular 45 per diem charge on foreign equipment.

The estimates in Mr. Sherman's report last year before the Committee on Rivers and Harbors, of \$1.60 saving per ton on cotton, \$1.60 saving per ton on wool, \$0.95 saving per ton on lumber are made up of averages of rates from several different points and are extremely conservative.

There is an actual difference of 15 cents per hundredweight, or \$3 a ton, on cotton from New Orleans to Boston, and we now pay an additional 8 cents, or \$1.60 a ton, freight from Boston to Lawrence; 98,000 tons of cotton and wool were brought to Lawrence in 1914 by rail. If coal tonnage increased 30 per cent, it is fair to presume that cotton and wool shipments increased in proportion. This would mean about 135,000 tons of cotton and wool, which at \$1.60 a ton, would mean a saving of \$216,000, and which, added to the saving of \$420,000 on coal, would mean a saving of \$636,000 during the past year on three commodities alone.

There now moves between Lawrence and New York City 153,127,240 pounds—76,563 tons—of less than carload high-class freight annually, and about one-third that tonnage to Boston.

If this river is opened up, the whole surrounding territory is bound to contribute to the tonnage of the boat lines.

During the past winter New England has been suffering from an almost utter paralysis of its rail carriers. Never before has such a condition been known. With a navigable Merrimack River, this condition would have been impossible at Lowell, Lawrence, and Haverhill, as the coal and raw material which was blocking the yards would have been handled by water. At no time during the past winter has the river been closed by ice.

The normal number of cars in the Lawrence yard is 500 to 700. At times this winter there were 1,700 loaded cars awaiting delivery, of which as high as 800 have been coal in open cars, frozen hard.

Our desire is not to cripple the railroads by taking away their business. We are quite sure that, if they could be relieved of the necessity of handling coal even to our section of New England, they would then be in a position to devote their equipment, both rolling stock and motive power, to the handling of high-class traffic, which is now made to wait for the enormous coal tonnage which must be moved to keep the industries running.

When we consider the wear and tear on equipment, rent of foreign cars, huge increases in pay rolls, discontent of help on overtime work, and demands of employees for more wages; extra switching necessary on account of blockades, for which no charge can be made; claims arising from delays to perishable or seasonable goods that can not be handled promptly, all on account of the railroads' obligation to give preference to coal for industries—we can not agree with those who claim that the development of river navigation will injure the rail carriers.

We can not do business without the railroads—neither can we long continue to do business with the rail carriers in their present condition and with their present terminal facilities. There is very little possibility for enlargement of these facilities in such closely-built industrial communities as ours.

Water transportation will solve the problem for us.

We have the river at our doors.

There is always an abundance of water.

There is never serious interference from ice.

There are no engineering obstacles to be overcome.

We have the traffic already developed and ready to move.

The saving to us would amply cover the interest on any outlay necessary for deepening the river.

The city and the State have both committed themselves to the support of the project.

Your consent and your assistance is all that we need to make this project a reality.

It is your cooperation and favorable consideration which we are now invoking.
Respectfully submitted.

GEO. E. RIX,
Secretary and Traffic Manager.

The BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

SPECIAL REPORT OF THE MERRIMAC VALLEY WATERWAY BOARD.

[State Document No. 2169.]

THE COMMONWEALTH OF MASSACHUSETTS,
January, 1914.

To the honorable the Senate and House of Representatives of the Commonwealth of Massachusetts:

The Merrimac Valley Waterway Board, appointed under the provisions of chapter 708 of the Acts of 1912, respectfully submits its second and final report concerning an investigation of the Merrimac River, in accordance with the provisions of that act, and of chapter 59 of the Resolves of 1913, extending the time for filing said report to the second Wednesday of January, 1914, and the term of office of the board to February 1, 1914.

Chapter 708 of the Acts of 1912 is as follows:

“SECTION 1. Upon the passage of this act the governor, with the advice and consent of the council, shall appoint a board to consist of three citizens of the Commonwealth, one of whom shall be a member of the board of harbor and land commissioners. The governor shall designate the chairman of the board, which shall be known as the Merrimac Valley Waterway Board. The board shall receive such compensation as the governor and council may determine. The term of office of said board shall expire upon the making of the report hereinafter provided for.

“SEC. 2. It shall be the duty of said board to make a thorough survey and study of the possibilities of development of navigation and power in and along the Merrimac River, and, in so doing, to employ competent engineers and assistants and by personal inspection and by discussion with the people in the various cities and towns along the Merrimac Valley to ascertain the facts and to learn

the desires of the people along said river. The board shall hold meetings in the various cities and towns in said valley in regard to the development of the Merrimac River for navigation and power, shall make a thorough and comprehensive plan for such development, and shall make a report to the general court on or before the first day of February, nineteen hundred and thirteen, and accompanied by said plan and by such recommendations for legislation as the board may determine.

"SEC. 3. To meet the expense of said investigation and report, the sum of ten thousand dollars may be paid out of the treasury of the Commonwealth.

"SEC. 4. This act shall take effect upon its passage." [Approved June 4, 1912.]

This act comprehends—

Survey and study of possibilities of development of navigation in and along the river.

Survey and study of possibilities of development of power in and along the river.

Personal inspection and discussion with people in the various cities and towns along the Merrimac Valley to ascertain facts and learn the desires of the people along the river.

Public hearings.

Plans for development of river for navigation and power.

A preliminary report dated January 28, 1913, was made to the legislature, printed in House Document No. 1824 of 1913, and considered by the legislative committee on harbors and public lands. Up to that time the board, which held its first meeting August 23, 1912, had given public hearings at Newburyport, Haverhill, Lawrence, Lowell, and Amesbury; made inspections of the river from Lowell to the sea; conferred with the district engineer officer in charge of river and harbor works in the territory including this river; ascertained, both by personal interviews and by correspondence, facts and general information concerning the desires of the public, the developed water power, the character and amount of business carried on in the several cities and towns along the river, and collected statistical matter in as complete form as possible. Furthermore, for the purpose of studying present river conditions, including depths of water, obstructions to navigation, number and location of bridges, and other data, a map of the whole length of the river in Massachusetts was prepared from surveys and maps by the Federal Government and by the State of Massachusetts, and from other sources. A survey had also been commenced of the territory at and near the dam at Lawrence, which is described later in this report.

It was stated in the preliminary report that the term of office of this board should be extended for the purpose of making further surveys and examinations and continuing work then in progress, "In order that there may be no delay on the part of the State and the various municipalities in carrying out such work, supplementary to that of the Government, as will provide the facilities necessary to carry on the large amount of business which will surely follow the opening to navigation of the whole river."

A very important consideration in connection with this investigation was the fact that the river and harbor act of Congress, approved July 25, 1912, provided for a preliminary examination of the Merrimac River, "with a view to securing increased depth from Lowell to the sea or in any part of this section of the river." When entering upon its studies of the problem involved, the board found that inquiry covering substantially the same matters included in the legislation of 1912 aforesaid, as well as others in addition, was contemplated by the United States engineer officer stationed at Boston, in compliance with his instructions. Consequently, conferences were held, and a plan of co-operative procedure discussed and adopted for the purpose of avoiding duplication of work and procuring all possible information and data to enable that officer, as well as this board, to prepare full and comprehensive reports. In pursuance thereof copies of the stenographic reports of public hearings held by this board, and of statistical and other information collected were furnished the district officer, and have been used and quoted at length in his report. The board has also been greatly aided in its work by the receipt of facts and figures in the possession of that officer.

Early in March, 1913, this board directed its engineer to make an examination and survey of that part of the river from Ward Hill to the pool above the Lawrence Dam—

(1) For the purpose of preparing plans and estimates of the cost of an adequate channel.

(2) For the purpose of preparing plans and estimates of cost for building a canal, with suitable locks, on the upland along and near the south bank of the river, connecting the pool above the Lawrence Dam with the channel of the river, just below Ward Hill. Statement, in detail, relating to this and other surveys, is made on subsequent pages of this report.

Up to April 1, 1913, there were nine regular meetings of the board, in addition to the public hearings and conferences previously mentioned, at which many matters relating to the subjects under investigation were considered. Later in this month application was made to the Chief of Engineers, U. S. Army, for a copy of the report of Col. Frederic V. Abbot, Corps of Engineers, U. S. Army, dated March 29, 1913, on his preliminary examination of this river, required by the river and harbor act aforesaid, and the same was subsequently furnished. This clear, logical, and comprehensive report is so instructive and describes so completely existing conditions, that all portions thereof which are material to this inquiry are incorporated in and **made part of the report of this board.** The first extract therefrom, and which is of primary importance to the Commonwealth, is as follows:

"Survey.—Whether the creation of a channel 18 feet deep and 200 feet wide, suitably widened at the bends, which will safely permit 17-foot draft vessels to navigate the river, is practicable, is largely a matter of cost. If the material can be removed by powerful dredges, without drilling and blasting, the cost may or may not be excessive, depending on the yardage, which can be ascertained only by an accurate hydrographic survey from the bar to the point opposite Ward Hill, where it has been recommended that the United States turn over the river to the State for improvement. If large quantities of rock are found by boring it may be necessary to combine dredging and slack-water navigation below Ward Hill; accurate and numerous borings are therefore unavoidable before any definite project or any approximation to the cost of such a channel is possible. While there are reliable maps of portions of the river, there are long reaches for which no reliable data are available. It is intended to avoid duplicating work by using such known data as are available, and supplementing them by new surveys.

"The question of cost must be determined within reasonable limits before it is known to what extent cooperation by the State should be asked; it seems, therefore, that the United States should make an accurate survey of the river up to Ward Hill, provided the State will undertake a similar survey for a canal from Ward Hill to connect with the pool above the Lawrence Dam. It is understood that there is a considerable State appropriation now available for such a survey, and there is little doubt that the balance would be provided by the Commonwealth of Massachusetts if such provision was made a condition precedent to a survey up to Ward Hill by the United States. By following this course cooperation by the State and Federal Government would begin at the very start, and there would be good ground for confidence that the local authorities were thoroughly in earnest, and that the improvement was worthy of being made by the State and the United States jointly.

"It is therefore recommended that an allotment for a United States survey of the Merrimac River from Black Rocks Beacon up to Ward Hill, with a view to the creation of a channel 200 feet wide and 18 feet deep at mean low water, suitably widened at the bends, be made; its expenditure to be conditional upon the provision by the State of sufficient funds for the making, by competent State authority, of an accurate survey for a canal to afford 18 feet depth and 200 feet width, suitably widened at the bends, connecting the pool above the Lawrence Dam with the channel of the Merrimac River just below Ward Hill. Under no conditions should the United States undertake to make a survey above Ward Hill, even if the State offers to defray the cost; for the legal questions as to State and Federal relationships to water powers on that part of the river are so involved that the whole matter of the extension above Ward Hill, survey as well as construction, operation, and maintenance of the canal, should be strictly the State's contribution to the improvement of the river."

The views and recommendations of Col. Abbot having been concurred in by the higher authorities, he was authorized to undertake—

"a survey of the Merrimac River from the mouth to Ward Hill, to be made under the condition that the State shall make an accurate survey and prepare a project, with estimate of cost, for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell."

It was further provided, and stated in a letter from Col. Abbot to this board, dated May 28, 1913, that—

“the survey to be made by this office is to include studies for a channel over the bar at the entrance to the river of suitable depth to accommodate a draft of 17 feet at mean low water. The survey will be undertaken as soon as the proper State authorities have given assurance satisfactory to the Secretary of War that the State will make an accurate survey and prepare the project and estimated cost of the 18-foot channel for a suitable width from Ward Hill to Lowell.”

This letter was considered at a meeting held May 29, 1913, and it was “voted, that this board, acting under authority conferred upon it by the Legislature of Massachusetts and contained in chapter 708 of the Acts of 1912 and chapter 59 of the Resolves of 1913, make an accurate survey of the Merrimac River from Ward Hill to Lowell, and that a project be prepared, with estimate of cost, for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell,” in compliance with the conditions contained in said letter.

This survey and estimate, as well as a project for improvement, have been made and prepared under the direction of this board, and are described later in this report.

* * * * *

INVESTIGATIONS, SURVEYS, AND EXAMINATIONS MADE BY THE COMMONWEALTH OF MASSACHUSETTS.

The provisions of chapter 96 of the Revised Laws relating to tidewaters, and defining the powers and duties of the Massachusetts board of harbor and land commissioners, are applicable to that part of the Merrimac River where the tide ebbs and flows, and that board has exercised its jurisdiction over the same for years, with respect to encroachments, the building of bridges, wharves, and other structures, and otherwise. The Commonwealth has not made any expenditures under the direction of that board for dredging or otherwise improving the navigation of this river, but in 1902 ordered an investigation to be made by the board of harbor and land commissioners and a report submitted to the legislature on the possibility and advisability of opening this river to navigation from Lowell to the sea. This report was printed in the annual report of that board for 1902, and set forth in general terms the examinations, surveys, and projects made by the Federal Government up to that time, the situation at Lawrence and Lowell, including the canals and locks and other matters. In speaking of the method of improving navigation between Haverhill and Lawrence, the opinion was expressed that the best way would be the “construction of a dam and lock at Mitchells Lower Falls, the removal of bowlders and the dredging in shoal spots of the river between the upper falls and the lower lock in the canal at Lawrence, and the raising of bridges or the substituting of drawbridges over the canal from the lower locks to the dam of the Essex Co. at Lawrence. * * * It is assumed that a dam at Mitchells Lower Falls 4 feet high, with a lock of about the same size as the lower lock of the canal at Lawrence, would be sufficient. That would allow navigation of the river from Haverhill to the lower locks at Lawrence for barges drawing about 4 feet of water.”

“There are three locks in the lower canal at Lawrence, 100 feet long and 20 feet wide, but over the sill of the lower lock there is only about 2.5 feet of water at ordinary low water in the river. After passing the lower locks into the canal there are 14 bridges over the canal, connecting the city proper with the mill yards. Five of the bridges are railroad, two are highway, and seven owned by the Essex Co. and several mills, for the mill operatives, teaming, and general use. The distance from the lower locks to the dam is about 1 mile. Under these bridges there is very little headroom—in some instances not over 2 feet. It would be impracticable for barges or lighters to use the canal without raising the bridges or constructing draws therein.

“The fall of the river at Lawrence from the dam to the lower locks is about 28 feet.”

In describing the river above the Lawrence Dam, the board say:

“From the dam at Lawrence to Hunts Falls, below Lowell, at the junction of the Merrimac and Concord Rivers, about 9 miles, navigation is practicable after dredging away the shoals and bowlders near its upper end.

“At Hunts Falls there are two sections, the upper and lower falls. From the basin above the falls, near the first lock on the Lowell Canal to the basin below, is about 5,700 feet, and in that length of river there was a fall of about

11 feet in 1881. This has been reduced by the Locks & Canal Co., so that now the upper basin above the falls is only 7 or 8 feet higher than the basin below the falls.

"The fall in the river in the 9 miles from Lawrence Dam to Hunts Falls is only about 1 foot, and the channel is from 5 to 30 feet in depth, excepting one rocky shoal and some bowlders which could easily be removed. At Hunts Falls the current is very rapid, and the river bed is rocky and irregular, and only 2 or 3 feet in depth for some distance.

"At Hunts Falls, in the opinion of the board, it would be necessary to construct a dam and lock to aid navigation. It would not be practicable to cut away the falls sufficiently to allow barges to be drawn through a channel, because this would decrease the depth of water in the river above to less than the required navigable depth.

"There are three locks in the canal between the Concord River and the pond above the Lowell Dam. The length of the locks, respectively, is about 100 feet; the width of the lock gates is only 12 feet, and the locks would be available for craft drawing only 3 feet of water.

"This canal from the lower locks at the Concord River junction to the dam above passes directly through the city. The fall from the dam to the lower lock is about 32 feet. Across this canal also are five highway bridges, three railroad bridges, and two mill bridges. Just above the lower locks is an old highway bridge, and the headroom between the average surface of the water in the canal and the truss of the bridge is only 18 inches. This is a much-traveled street in the city, fully occupied on both sides with mills, warehouses, or stores. It would be very expensive to raise the bridge, on which buildings have been erected on either side of the traveled way, or to make a draw therein."

The concluding portions of this report are:

"The canals at Lawrence and Lowell are now very little used for the passage of boats. Many years ago rafts of logs and spars or masts were carried through the locks. There was also some other freight carried through the canals. Careful records of both canals have been kept of the passage of barges, rowboats, launches, and canoes. The locks have been used for that purpose only a few times each for the last 25 years. No freight has passed through the canals for many years.

"The locks of the Lawrence Canal have been little used for the last 25 years. * * * The cost of the dam and lock at Mitchells Falls and at Hunts Falls, respectively, and the dredging of shoals and bowlders at several places in the river between Haverhill and Lowell would be the smallest of the items of cost. A very large expense would be the raising of the bridges to make more headroom, or providing the same with suitable draws; but larger than all would be the damages caused by the loss of power to the many mills on the banks of the two canals, and no approximate estimate of the cost can be given.

"The dam at Michells Falls would decrease the flow and fall of water at the lower locks and mill raceways in the canal at Lawrence. This would probably not cause so large damage and loss of power as the dam and lock at Hunts Falls in Lowell. The building of a dam there would reduce the water power available for all the mills on the several canals in Lowell about 4 feet.

"The cost of the work, including the building of two dams and locks, dredging shoals, removing bowlders, damages to water power and cost of street and bridge changes in Lawrence and Lowell, could only be accurately determined after a long and expensive investigation by engineers and experts.

"When completed, as above suggested, without substantially enlarging the locks (except at the lower lock in Lawrence), the river would be navigable to and through Lawrence by barges 20 feet wide, 100 feet long and drawing 4 feet of water; and to and through Lowell by barges 12 feet wide, 100 feet long and drawing 3 feet of water. Barges or craft of that size would not be safe for transporting freight even from Boston harbor. All freight for Lawrence or Lowell would require rehandling at Newburyport or Haverhill.

"The amount of freight tonnage for the cities of Lawrence and Lowell should be considered in this connection. For the year ending June 30, 1902, all the freight carried into the two cities by the Boston & Maine Railroad was as follows:

Carried into Lawrence:	
Tons of coal_____	246, 031
Tons of all other freight_____	450, 917
Carried into Lowell:	
Tons of coal_____	295, 697
Tons of all other freight_____	520, 145

“Coal would be more likely to seek water transportation than other freight. The mills for the most part have spur tracks to their boiler rooms. The necessary rehandling of coal in the lower river and the carting from canal to boiler room would have to be added to the water-borne freights in offsetting the greater all-rail coal rates; and the difference in cost of transportation would probably be small. The outgoing freight from the two cities would largely be by rail.

“The work of opening the Merrimac River from Lowell to the sea would be feasible and practicable from the engineering point of view; but, considering the large cost and the damages involved, and the relatively small savings on freight which must be rehandled on the lower river and transported in such small barges, the board reports that, in its opinion, it is not advisable for the State to undertake the large expense of opening the river to navigation from Lowell to the sea.

“The United States engineers have for years made surveys and reports on this work, and the United States has expended large sums to improve the navigation of the Merrimac River. Apart from the large expense, it may be better to leave the work in sole charge of the United States.”

Notwithstanding this adverse report, municipalities, boards of trade, and other organizations, Representatives in Congress, as well as public-spirited citizens in the Merrimac Valley, have kept alive the movement for an improved waterway, bringing about in 1912 the legislation under which this board is acting and cooperating with it, as well as independently, in collecting facts and data required by it and the engineer officer engaged in a preliminary examination of the river under authority of the river and harbor act of Congress.

BRIDGES, DAMS, LOCKS, AND CANALS ON MERRIMAC RIVER.

Present condition.—The river between Newburyport and Haverhill is crossed by eight bridges, six of which form a part of highways and two are Boston & Maine Railroad bridges. The clear height at mean low water varies from 19.5 feet, the lowest, to 41.5 feet, the highest. There are draws in six, varying from 38 feet, the smallest, to 76 feet, the largest, for the passage of water craft. The two upper bridges, namely, the Boston & Maine bridge at Haverhill, and the highway bridge at Haverhill, known as county bridge, have no draws therein, the clear height at mean low water being 41.5 feet at the railroad bridge and 32.5 feet at the highway bridge.

Between the county bridge at Haverhill and the Lawrence Dam there are the following bridges: Union Street, Boston & Lowell Railroad bridge, Boston & Maine Railroad bridge, Broadway Bridge.

Between the Lawrence Dam and Hunts Falls there are no bridges across the river.

BETWEEN HUNTS FALLS AND THE PAWTUCKET DAM AT LOWELL.

Name of bridge across Merrimac River.	Type of bridge.	Used for what purpose.	Approximate grade under side of truss above locks and canals datum.	Elevation of water (feet).	
				Ordinary height.	In extreme freshet (Mar. 3, 1896).
Centralville.....	Steel truss.....	Highway and street cars.	67.7	45.0	63.2
Aiken Street.....	do.....	Highway.....	73.3	46.0	65.0
Moody Street.....	Deck steel truss...	Highway and street cars.	82.6	55.0	81.4
School Street or Pawtucket.	Steel truss.....	do.....	97.1	65.0	90.7

BETWEEN THE PAWTUCKET DAM AT LOWELL AND THE STATE LINE.

Vesper Country Club....	Suspension.....	Private foot bridge.....	108.5	¹ 87.0	100.7
Tyngsborough.....	Steel truss.....	Highway.....	104.6	¹ 87.0	102.8

¹ Top of flashboards.

The construction of a central bridge, with suitable approaches, over this river, at a point between the present Broadway Bridge and Union Street Bridge, has been authorized and provided for by the legislature in chapter 513 of the Acts of 1906, chapter 486 of the Acts of 1907, and chapter 640 of the Acts of 1913, and it is understood that plans are now being prepared under the direction of a special bridge commission.

In order to make use of an improved river channel, as indicated in this report and shown on the accompanying maps and plans, any plan adopted by this bridge commission should provide for a structure with a draw therein having an opening of not less than 50 feet in width.

By license granted by the board of harbor and land commissioners July 24, 1912, the county commissioners of Essex County were authorized to extend the center pier of the bridge between Haverhill and West Newbury, known as Rocks Bridge, by building a timber crib at the northerly end of said pier and to jacket with wood the westerly stone pier of said bridge, to carry out certain requirements of the War Department.

By chapter 613 of the Acts of 1913 the county commissioners of Essex County were authorized to reconstruct that part of this bridge which lies east of the draw. Plans of the proposed work were approved by the board of harbor and land commissioners September 3, 1913, it being provided in the license granted that the foundations of the pier nearest the channel and draw be at such depth as to allow future deepening of the river channel to 18 feet at mean low water without impairing the stability and safety of the bridge.

By chapter 826 of the Acts of 1913 the county commissioners of Essex County were authorized to repair or reconstruct that part of the bridge between Haverhill and Groveland, known as Groveland Bridge, which lies east of the draw. Plans of the proposed work were approved by the board of harbor and land commissioners September 3, 1913.

No changes in the draw ways of these bridges were required by these licenses.

DAMS AND WATER POWER.¹

The first step toward the construction of any hydraulic works on the Merrimac River was taken June 27, 1792, on which date a corporation, known as the Proprietors of the Locks and Canals on Merrimac River was chartered for the purpose of improving the navigation of the river and rendering it navigable by boats from tidewater to the New Hampshire line.

The dam at Lawrence, built of stone and near the foot of what were known as Bodwells Falls, the first structure of that kind reached in passing up the Merrimac River from Haverhill, was completed in 1848, and is owned by the Essex Co., incorporated in 1845.

This dam creates a pool and deadens the current as far as the foot of Hunts Falls, and gives a pond area of about 29,000,000 square feet.

There is a canal on each side of the river; the one on the north side being about 5,330 feet long, 100 feet wide at the upper end, and 60 feet at the lower end. At the head of this canal there is a lock and at the foot three locks descending into the river.

The south canal was built in 1866, and carried for a distance of 2,000 feet, with a rectangular section 60 feet wide and 10 feet deep.

The dam at Lowell, known as the Pawtucket Dam, is the next structure of that character existing above the Lawrence Dam at Lawrence. The canal known as the Pawtucket Canal was built before 1800, having been opened in 1796.

In 1822 the Merrimac Manufacturing Co. was incorporated and this company in that year enlarged the Pawtucket Canal.

It appears that in 1821 there was a wing dam at the head of the falls, together with a saw and grist mill. This dam extended to what is known as Great Rock, and its top was several feet below the top of the present dam. In 1825 there was a temporary dam across the river, and in 1826 the Merrimac Manufacturing Co. appeared to have made a beginning on a new dam, but in that year this company transferred its real estate to the Proprietors of the Locks and Canals, which completed the dam in 1830 to 2 feet below its present height. It was raised 2 feet in 1833 by putting on two courses of granite stone.

¹ In part from water power of United States; census of 1880.

In 1847 that part of the dam between Great Rock and the gatehouse was rebuilt in its present position, to conform to the entrance to the northern canal, which was built during that and the previous year (1846).

In 1869 the directors considered the propriety of rebuilding the remainder of the dam from Great Rock to the north side of the river, but it was not decided to commence the work until February, 1875. A new dam was built on nearly the same site as the old one. This dam deadens the current in the ordinary state of the river for about 18 miles, forming, in low water, a reservoir of about 1,120 acres. The dam is situated at the head of what are known as Pawtucket Falls, and for a distance of about one-half mile below the gatehouse the bed of the stream is solid rock, and the banks high and rocky.

Two canals lead the water from above the dam, the original Pawtucket Canal, enlarged in 1822 and 1823, and the northern canal, both on the south side of the river. Various other canals intersect these two.

The fall at Lowell, at ordinary low water, is about 40 feet, of which about 3 feet is lost in consequence of the descent in the canals, leaving a net fall of about 37 feet.

The Lowell mill pond extends to the foot of Cromwells Falls, 4¼ miles above Nashua and 17¾ miles above Pawtucket Dam. From this point up to Manchester, N. H., a distance of about 13 miles, the river rises about 33 feet.

The water power derived from the river at Lowell is controlled and operated for 10 different manufacturing corporations by the Proprietors of the Locks and Canals on Merrimac River. The turbine water wheels now established are capable of drawing from the pond above the dam through the canals 9,211 cubic feet per second and developing 29,911 horsepower. Additional or larger wheels are occasionally put in. All power developed here is used in manufacturing upon adjacent mill sites.

At Lawrence the water of the river is controlled and operated and furnished to the several manufacturing corporations by the Essex Co. The turbine wheels now established are capable of drawing from the pond above the dam through the canals 9,906 cubic feet per second and developing 25,251 net horsepower.

A record of the craft passing through the Essex Co.'s north canal during the years 1908-1912, inclusive, is as follows: ¹

Year.	Launches passed.	Row-boats.	Canoes.	Sail-boats.	People.	Craft carried by L. locks.	Dories.	Craft.		
								Up.	Down.	Total.
1908.....	8	.....	8	1	29	8	.....	5	12	17
1909.....	22	1	9	1	55	9	1	16	18	34
1910.....	16	.....	7	.....	48	8	2	10	15	25
1911.....	15	.....	9	.....	61	9	1	7	18	25
1912.....	17	2	13	.....	79	15	1	16	17	33

SURVEYS, MAPS, AND PLANS BY THE MERRIMAC VALLEY WATERWAY BOARD AND PROJECT FOR DEVELOPMENT.

For the purpose of ascertaining the feasibility, merits, and probable cost of a canal on the south side of Merrimac River from a point on the river bank just below Ward Hill to the pool above the Lawrence Dam surveys were made by Mr. George W. Wood, of Malden, Mass., civil engineer, who was engaged to make surveys, examinations, and estimates of cost in connection with this inquiry. This survey covered two locations for the canal, one entirely on the south side of the Boston & Maine Railroad, connecting with the river just below Ward Hill cut; the other beginning at the same river point, below Ward Hill, and following the Ward Hill railroad cut, the south bank of the Merrimac River, crossing the Boston & Maine Railroad near the mouth of the Shawsheen River, thence to the same point above the Lawrence Dam.

The valuation of the property which it would be necessary to purchase or take on both of these locations was obtained, and the physical difficulties and other matters connected with the construction of such a canal as would serve the purpose of allowing the passage of vessels from the lower river to a point above this dam were carefully considered.

The conclusion reached by the board was that, owing to the land damages, which would amount to a large sum, the cost of necessary bridges at various

¹ Furnished by the Essex Co.

streets in North Andover and South Lawrence, the relaying of sewers, water mains, and car tracks, the large amount of water which would be required in the canal, and particularly as such a canal would not, in the judgment of this board, best serve the business interests of Lawrence, a channel dredged in the river and canals constructed across Ward Hill and at the Lawrence Dam would be a better solution of the problem.

The project developed on these lines is described later and shown on the maps and plans annexed to this report.

Access to and use of surveys and maps of sections of the river made by the Essex Co. and the Proprietors of Locks and Canals were courteously allowed.

The length of river between the Lawrence Dam and the upper limit of this survey at Hunts Falls is about 8.8 miles, and between the Lawrence Dam and the lower limit about 6.5 miles.

The stretch of river from the upper limit of the board's survey to the boundary line between Massachusetts and New Hampshire is about $11\frac{1}{2}$ miles, and the board's inquiry with respect thereto has necessarily been confined to an inspection and the collection of such data as will be valuable for future use in preparing a project for improvement of navigation as far as the State line, which, if carried into effect, would not only benefit those communities along the river banks in Massachusetts, but, if extended, would be of the greatest advantage to the cities of Nashua, Manchester, and other points on the river front in New Hampshire.

Immediately after this board's acceptance of the condition previously referred to, that the State should make a survey of the Merrimac River and prepare a project, with estimate of cost for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell, the engineer was instructed to supplement the surveys already made by him by one between the points indicated above; to direct and supervise the work of making borings necessary to determine the character of material which would probably be encountered in carrying out any project involving excavation and dredging, either wholly in the river or partly in the river and partly across a portion of the adjoining shore within this stretch of river; to prepare a map showing thereon the shore lines, topographical features, soundings, and other details, also the location and width of the proposed river channel; and to prepare and submit a report and estimate of cost of the necessary dredging and excavation to provide a channel 200 feet wide and 18 feet deep from Ward Hill to Lowell.

Subsequently, Edward C. Sherman, civil engineer, of Boston, Mass., was employed to act as consulting engineer, and advise the board on important engineering questions involved in this investigation, including a study of the existing conditions at the Lawrence dam, the building of locks, canals, and dams, the rebuilding of existing structures, and to submit a report, with plans, estimates, and suggestions, as to the necessary works, their probable effect, if any, upon the valuable water-power privileges at Lawrence and Lowell, the creation of additional water power in the river, together with any other matters pertinent to this investigation.

The project which the Merrimac Valley Waterway Board has prepared, based on the surveys and examinations made by its engineers, and shown on the accompanying plans, provides for a navigable channel 18 feet deep by dredging in the Merrimac River, and by excavating and building a canal and locks at Ward Hill and a canal and locks at the Lawrence Dam, which would permit the passage of vessels of 17 feet draft, which might proceed from the open sea up river in a channel 18 feet deep to a point opposite Ward Hill, below the Lawrence Dam, thence to Hunts Falls at Lowell.

The total length of the improved waterway would be about 15.3 miles, of which about 34,175 feet, or about 6.5 miles, would be below the Lawrence Dam, and about 46,540 feet, or about 8.8 miles, above that dam.

The width as well as the depth of the river channel would be the same, namely, 200 feet and 18 feet, respectively, as that recommended for an improved channel from the sea to a point opposite Ward Hill, and as described in the preliminary report of Col. Frederic V. Abbot previously quoted from.

The location of the canal to be constructed at Ward Hill is shown on the accompanying plans, and would extend from the river channel to be dredged up to Mitchells Falls, through the adjoining upland southerly of the river, a distance of about 4,255 feet, connecting again with the river at a point just above Kimballs Island. The width of this proposed canal would be 100 feet and the depth 18 feet. The dimensions of the proposed lock at the entrance to the canal down stream would be as follows: Usable length, 350 feet; width, 45 feet; depth

at gate sill, 18 feet. It is also proposed to provide an additional small lock for the use of small boats, leading from the westerly side of the turning basin in the Ward Hill Canal to the river, for convenience and saving time.

The proposed canal and lock at the Lawrence Dam would be located on the north side of the river, as shown on the accompanying plans, extending from a point below the dam to the pool above. The dimensions of this lock would be the same as the one proposed at the Ward Hill Canal. As practically the entire normal flow of the river at Lawrence is used for power purposes, it is necessary to conserve for that purpose as much of the water as possible, using only so much as may be absolutely required for lockage. It is proposed to divide the usable length of lock, 350 feet, into two chambers of about 110 feet and 240 feet, respectively, by means of intermediate gates, so that for any vessel a lock chamber of suitable length can be provided.

It is proposed to provide, in addition to the lock at Lawrence above described, a flight of two small locks, each about 50 feet long, 10 feet wide, and 5 feet deep at low water, to be built adjacent to the large lock, for use by motor boats and other small craft, thus conserving the water supply and avoiding use of even the 110-foot chamber of the large lock.

The board has carefully considered the subject of constructing a dam across the river at a point about 1,700 feet below the lower end of Kimballs Island, where the stream is about 400 feet wide, which would hold back the water and create a pool at a level which would not interfere with the flow from the water wheels at Lawrence, thus reducing to a minimum the amount of excavation necessary for the channel.

The consulting engineer, in speaking of this proposed dam, says:

"The water can not be permitted to back up to a higher elevation at Lawrence than it does now. At the same time, a reasonably tight dam with its crest at about elevation 4.5 should be available during times of low flow * * *. Owing to the very considerable rise of the river in time of flood, and to the presence of ice floes in the spring, the most satisfactory dam would be one of those which fold down on the bottom of the stream * * *. It is probable that a dam of the bear-trap type would best serve the purpose * * *. The proposed dam would consist of four bear-traps, each about 90 feet long, set between permanent masonry end abutments and three river piers. The piers would also provide supports for a combination highway and service bridge * * *. No design has been made for this dam * * * but from sketches it has been roughly estimated to cost about \$310,000."

The necessary changes at the Lawrence Dam and work other than that already described above would be substantially as follows:

The total length of this dam, which is now on its crest 897 feet, would, after its proposed extension of about 175 feet at its south end, be reduced to about 875 feet by the construction of the proposed locks.

Above and near the Lawrence Dam the excavation of a new entrance to the north power canal and some changes at the south power canal would be necessary.

It is proposed to excavate a channelway in the rock near and below the Lawrence Dam to compensate in part for the restrictions of the river flow, and to further improve conditions by removing the present Broadway Bridge and building a new double-deck structure on the site of the present Boston & Maine Railroad bridge, to serve for both highway and railroad.

It would be advantageous to have but one drawbridge over the lock at Lawrence, and by means of this new combination bridge the existing grade crossing and attendant dangerous conditions could be eliminated.

Other bridge changes would be of minor importance, comparatively, and would include the rebuilding of a portion of the present bridge, known as the Boston & Maine Railroad bridge, with a draw therein; also the rebuilding of Union Street Bridge with a draw, the passageway for water craft through each bridge to be not less than 50 feet wide.

The studies made by the consulting engineer have included one concerning a power plant which might be installed to develop power necessary for operating the locks at Ward Hill and Lawrence, to light the canals and the navigable river channels. It would be possible to pump back, over the Lawrence Dam, an amount of water equal to that used in lockages to fully compensate the owners of the power rights, although further investigation and consideration of this subject may show that such a project would be inadvisable.

The engineers' reports, with estimates in detail, are printed in the appendix to the board's report, and, with the maps and plans which have been prepared, are referred to as showing existing conditions and the projected improvements.

CONCLUSIONS AND RECOMMENDATIONS.

The recommendations and other matters contained in the report of Col. Frederic V. Abbot, which has been largely quoted in the report of this board and which provide for certain cooperation between the Federal Government, the State, and the municipalities, are as follows:

(1) *Newburyport as upper limit of improvement for 17 feet draft.*—Assuming that a survey does not develop excessive rock areas, it would seem that this work would be so comparatively inexpensive that it can be reported as being worthy of being done by the United States, on condition that the State or municipality expend an equal sum in deepening the water between the channel and the wharves and in providing a suitable public terminal open to all water carriers on equal terms and connected with the railroad for interchange of water-borne and railroad-borne traffic.

(2) *Haverhill as upper limit of improvement for 17 feet draft.*—No 17-foot dredged channel can probably be provided to Haverhill for less than \$1,600,000. * * * This plainly indicates that State or municipal cooperation must be a condition precedent to any work by the United States. * * *

It would, then, seem not unreasonable to assume that if the State would guarantee maintenance of 17 feet draft to Haverhill at mean low water and would contribute half the cost of original improvement the United States might be justified in putting not to exceed \$800,000 into a 17-foot-draft channel to Haverhill if a survey should indicate that such a channel could be provided for \$1,600,000. * * *

The above is sufficient to show that without a full and complete survey and borings in the bed of the river from the mouth up no fair report on the worthiness or unworthiness of a channel permitting vessels drawing 17 feet to reach Haverhill can be made.

(3) *Lawrence as upper limit of improvement for 17 feet draft.*—The cost of carrying 17 feet navigation above Haverhill into the Lawrence Pool can not well be less, and is almost certainly greater, than the cost to Haverhill, the head of tidal navigation, if a 17-foot open channel be dredged to that point. It would seem that if 17 feet is to be given above Haverhill it should be done by the State, which now, under State charters, has full control of the water-power situation. Such a cooperation on the part of the State or municipalities would be equivalent in effect to contributing at least half the cost of making Lowell and Lawrence seaports and would probably justify the United States in doing the work up to Haverhill, or perhaps to 1 mile above Haverhill, where the State canal south of Ward Hill would enter the river. * * *

With a pledge from the State to complete a 17-foot-draft canal from the Merrimac River 1 mile above Haverhill into the Pool above the Lawrence Dam and to operate the same free of tolls forever, it would then seem that the project of giving 17 feet draft to Haverhill at the cost of the United States might be a worthy one to be undertaken by the United States if a survey does not show too great cost. * * *

The possibilities seem so great that I report without hesitation that the river is worthy of the cost of such a survey up to Ward Hill, about a mile above Haverhill. Above that point the surveys should be at State expense, as they are to do the work if the above recommendations are adopted by Congress.

CONCLUSIONS AND RECOMMENDATIONS OF THE MERRIMAC VALLEY WATERWAY BOARD.

A summary of the statistical information collected by this board shows the following facts concerning the cities and towns along the Merrimac River in Massachusetts:

Total population	307, 540
Total value of assessed estates, Apr. 1, 1913	\$262, 710, 204
Total number of establishments	814
Total capital invested	\$188, 152, 336

This represents about 53.1 per cent of the capital invested in metropolitan Boston (including Boston and 39 other cities and towns), and about 14.4 per cent of that invested in the whole State.

Total value of stock and material used.....	\$116, 870, 360
This represents about 36.5 per cent of that of metropolitan Boston, and about 12.6 per cent of that of the whole State.	
Total amount of wages paid during the year.....	\$42, 004, 459
Total number of wage earners employed during year.....	85, 069
Total value of product.....	\$196, 595, 077

This represents about 36.1 per cent of the total value of product of metropolitan Boston, and about 12.4 per cent of that of the whole State.

The total local consumption of these cities and towns exceeds 1,200,000 tons, only about 135,000 tons of which is now received by water. In the opinion of the manufacturers along the river an adequate water route for the receipt of this commodity would effect a saving in freight rates of from 50 cents to \$1 a ton in addition to the saving in transportation charges on general merchandise, raw material, and manufactured product.

The estimated total cost of carrying out the project prepared by the Merrimac Valley Waterway Board for improving the river from Ward Hill to Hunts Falls at Lowell is \$5,443,600, which is exclusive of land damages at Ward Hill; of the cost of removal of Broadway Bridge at Lawrence and the construction of a new bridge at that point; and of the cost of making certain changes in existing bridges between Ward Hill and Broadway Bridge. This total cost would be reduced about \$226,800 if the width of the proposed channel from the Lawrence Dam to Hunts Falls was reduced from 200 feet to 100 feet. Assuming the estimated cost of carrying out the Federal Government project of improvement from the sea to Haverhill to be approximately \$1,600,000, as stated in the report of Col. Abbot, the total cost of improving the Merrimack River from the sea to Lowell in the manner and to the extent shown would be approximately \$7,043,600.

The large expenditure necessary for improving the stretch of river between Ward Hill and the Lawrence Dam is due to several factors, including the character of the material which would be encountered in the excavation, largely rock and ledge; a canal and locks at Ward Hill; a dam in the vicinity of Kimballs Island designed to form a pool above the same, and thus minimize the amount of expensive excavation and dredging required to obtain 18 feet of water without, however, injuriously affecting the existing valuable water-power privileges at Lawrence; and a canal and locks for passing the Lawrence Dam, necessitating a curtailment of its present length, and its future extension to the south as a compensatory provision.

Above the Lawrence Dam the survey does not disclose conditions which would call for the payment of a large amount per cubic yard for dredging to obtain a depth of 18 feet, but as the section of river to be improved is about 8.8 miles in length the estimate of cost for a channel 200 feet wide amounts to approximately \$567,000, and for a channel 100 feet wide approximately \$340,200.

As the results of the Government survey now in progress, and the report and estimate of cost by the United States Engineers based thereon, will not be a matter of public knowledge for some months the board in the following pages has set forth a suggested line of procedure which in its opinion should be carried out to show the Commonwealth's interest and willingness to aid in the projected improvement of this river.

The conclusions which have been reached by the Merrimac Valley Waterway Board, and the recommendations which it makes—after full consideration of all phases of the questions involved in the investigations intrusted to it, and having in mind the large amount of business carried on, as well as the large saving in cost of transportation and the resultant benefit generally to this section of the Commonwealth as shown by the statistics and data herein set forth, are:

(a) That the Merrimack River should be improved and opened to navigation by providing a channel 18 feet deep at mean low water extending from the sea to Ward Hill, about 1 mile above Haverhill, and by providing a depth of 18 feet by means of a channel and by building canals and locks from Ward Hill to Hunts Falls at Lowell.

(b) That the Federal Government carry into effect a project providing for a channel 18 feet deep at mean low water, from the sea to Ward Hill, about 1 mile above Haverhill, and that the Commonwealth of Massachusetts cooperate with the Federal Government in carrying such project into effect, the basis, form, and method of cooperation to be agreed upon after all facts and data have been obtained.

(c) That the Commonwealth of Massachusetts adopt and carry into effect the project prepared by the Merrimac Valley Waterway Board for the improvement of the Merrimac River from Ward Hill, about 1 mile above Haverhill, to Hunts Falls, at Lowell, substantially as outlined in this report, namely, by excavating a channel of adequate width and 18 feet deep in the river, and by building locks and canals to provide a depth of 18 feet, and that the Federal Government cooperate with the Commonwealth of Massachusetts in carrying such project into effect; and that the basis, form, and method of cooperation in respect to the State's project be agreed upon at the same time as agreed upon in respect to the Federal Government's project for improvement of the river as far as Ward Hill.

(d) That work under projects for improvement of the Merrimac River from the sea to Hunts Falls at Lowell be carried on progressively, upstream and in such manner and at such times as will insure the earliest possible completion of the projected channel as far as Lowell.

(e) That the board of harbor and land commissioners be given charge and jurisdiction over that part of the Merrimac River which is not tidal, substantially to the same extent as that board's powers and duties now apply to tide-waters; that said board be authorized to continue the investigation thus far made by the Merrimac Valley Waterway Board, particularly with reference to that part of the river from Hunts Falls to the State line, and the location of terminals, and to act in conjunction with the cities and towns in the Merrimac Valley in the furtherance of such plans and projects for improving this river as it may deem worthy, and to have charge of and supervise all works of improvement.

(f) That the legislature memorialize Congress to take early and favorable action looking to the improvement of the Merrimac River and its opening to navigation from the sea to Lowell, and urging that appropriations be made to carry out the necessary work in cooperation with the Commonwealth of Massachusetts.

(g) That an appropriation of \$1,000,000 be made by the legislature for the purpose of improving the Merrimac River, and as evidence of agreement by the Commonwealth to a policy of cooperation with the Federal Government with respect thereto, the expenditure of this appropriation to be conditioned upon the passage by Congress of appropriations for the same purpose.

The foregoing report is respectfully submitted.

CHARLES C. PAINE, *Chairman*,
ANDREW B. SUTHERLAND,
LEWIS R. HOVEY,
Merrimac Valley Waterway Board.

Appendix.

REPORT OF GEORGE W. WOOD, ENGINEER.

GENTLEMEN: I respectfully submit the following report on survey of the Merrimac River from Mitchells Lower Falls at Ward Hill to Hunts Falls, about 1 mile below Lowell, made for the purpose of obtaining the necessary data for determining the most desirable route for a navigable channel along that portion of the river, and an estimate of the cost of same.

In compliance with your instructions, I conferred with Col. Frederic V. Abbot, Corps of Engineers, U. S. Army, at his office, for the purpose of ascertaining his views, as he had been ordered by the department at Washington to make a report on matters concerning the Merrimac River.

I was informed that in order to make a comprehensive report he desired to consider the merits of a canal leading from the pool above the Lawrence Dam, overland, along the south side of the river and entering the river again just below Ward Hill, but that he lacked the necessary data, and no funds were available for making a survey. I was instructed by you to furnish the information desired, and accordingly a survey was made and plans covering this section were delivered to Col. Abbot.

A study of this scheme was made for your information.

One line was considered lying entirely on the south side of the Boston & Maine Railroad, entering the river just below the Ward Hill "cut"; another starting from the same point above the dam and crossing the Boston & Maine Railroad near the mouth of the Shawsheen River, thence following along the right bank of the Merrimac River to the Ward Hill railroad cut, occupying

the cut and entering the river just below; this line would necessitate the relocation of tracks in the cut.

A valuation of the property to be taken along both routes has been obtained and a study of the physical difficulties has been made.

On account of the large cost of land damages, the cost of building bridges at the various streets in South Lawrence and North Andover, relaying of sewers, water mains, electric car and steam car tracks, and on account of the large amount of water which would be required to operate the canal, and especially as such a route would not best serve the business interests of Lawrence, for which navigation of the Merrimack River was desired, it was thought best to abandon the overland project and confine all efforts to a study and an investigation of deepening the river bed from the Lawrence Dam to Ward Hill; thence by a canal across Ward Hill to the river below.

Through the kindness of the Essex Co. a large expense was saved by allowing free access to all their data pertaining to the matter, and accordingly assistants were employed in making tracings of their surveys and plans, and collecting all other information relative to the work in hand.

It was also necessary to do considerable field work in extending surveys outside of the data furnished by the Essex Co., and a thorough development of conditions at Ward Hill and the river below was made, also for several miles at and below Hunts Falls.

Col. Abbot in his report, dated March 29, 1913, recommended that a channel be created 200 feet wide and 18 feet deep, suitably widened at the bends. After careful consideration by your board, it was decided that these dimensions would meet all requirements, and plans and estimates have been made accordingly, i. e., for a channel 200 feet wide and 18 feet deep from Hunts Falls to Ward Hill, and for a canal 100 feet wide across Ward Hill.

Above Lawrence Dam.—The elevation at the crest of the dam is 34.12 feet above the Essex Co.'s reference plan, but during a large portion of the year flashboards raise the height of the pool to approximately 39 feet. On investigation it was found that the elevation of the water was seldom below elevation 36, consequently this elevation was considered to be a safe one on which to base an estimate for an 18-foot channel.

The distance from the dam to the upper end of a proposed turning basin at Hunts Falls is approximately 46,540 feet, or 8.8 miles; for nearly 3 miles of this distance very little dredging will have to be done, the deepest cutting being at the upper end of the channel just below the falls, where more or less bowlders will be encountered and several areas of hard clay and gravel. Borings taken over the entire distance at intervals averaging 400 to 500 feet apart, or sufficiently close to show any change in the material, did not indicate that ledge rock would be encountered above an elevation of +18, but that a large portion of the material could be easily handled, so that a unit cost of 35 cents per cubic yard for the total excavation would be a reasonable price. It is estimated that 1,620,000 cubic yards of material will have to be removed, including turning basin at Hunts Falls, making the total cost \$567,000.

Below Lawrence Dam.—The distance from the lower end of the proposed lock at the dam to the entrance of the canal at Ward Hill is approximately 29,920 feet, or 5.7 miles.

Borings were taken over this stretch from 400 to 500 feet apart where the material continued to be of about the same character, but where any change was found they were made at more frequent intervals. At the upper end many bowlders were encountered, but the surrounding material was of such character that it would not be difficult to remove them. Farther down the river ledge rock was found at several places.

In order to be able to permanently maintain a depth of 18 feet of water in the channel, it was found that it would be necessary to place an obstruction, such as a movable dam, in the river at some point below the entrance of the proposed canal.

The dam could only be built to such a height as would not back up slack water at the lower locks to an elevation that would interfere with the power; this elevation was assumed to be +3.7; consequently, this fixed the depth to which the excavation must be carried in order to obtain an 18-foot channel, or, in other words, to elevation -14.3. In addition to this, 1 foot has been allowed in the estimate for overdepth dredging.

This makes the total estimate of material from the lower end of the lock at the Lawrence Dam to the entrance of the canal at Ward Hill to be 3,311,000 cubic yards, of which 40,000 cubic yards is estimated to be ledge excavation.

The borings indicated that a large proportion of the material would not be difficult to excavate, and that the cost would not exceed 45 cents per cubic yard.

3,271,000 cubic yards of earth, at 45 cents-----	\$1, 471, 950
40,000 cubic yards of rock, at \$7-----	280, 000

Making the total cost of this portion of the work----- 1, 751, 950

Ward Hill Canal.—It is proposed to leave the bed of the river near the head of Kimballs Island and follow the depression across Ward Hill Point, entering the river again about 50 feet below the mouth of a brook. The center line of the proposed canal was laid out on the ground, and the necessary levels taken to determine the amount of excavation. On a plan submitted showing this route, there is a broken line indicating a slight change in direction, which will slightly decrease the amount of material to be removed.

The difference in elevation of the water surface at the upper end of the canal and that of the river at the entrance will necessitate the construction of a lock. Assuming the elevation of the water surface to be +3.7, as fixed by the dam in the river below Kimballs Island, and the elevation of mean low water at the entrance of the canal, where it is affected by the tide, to be -4.8, the difference is 8.5 feet; but as only a few observations were made this difference may vary a foot or more; probably the difference is about 9 feet. In order to accurately determine mean low water at this point, a long series of observations should be made.

It is assumed that a canal 100 feet wide would meet all requirements, and the estimate has been made on that basis. The distance across Ward Hill from river to river is 4.255 feet.

Borings, 27 in number, have been made along and near the center line, at such intervals as would give a fairly good indication of the material. Ledge rock was found much nearer the surface than was anticipated, and nearly every boring struck rock at an elevation considerably above the bottom of the canal (-14.3). The average cut is approximately 28.5 feet, for a distance of 3,585 feet.

It is estimated that there are 384,000 cubic yards of rock excavation from the entrance at Kimballs Island to the lock, including 0.5 foot for overdepth, and the cost of removing the same would be \$1.20 per yard, making a total of \$460,800; but on account of the large quantity, small risk of damage to property from blasting, and easy disposal of material this cost might be considerably reduced.

The amount of earth excavation covering the same distance and width, with side slopes of 2 or 1, not allowing for berms, is estimated to be 225,000 cubic yards. The larger part of this material, being of a sandy nature, could be handled easily, and it is estimated that the cost would be 25 cents per cubic yard, making a total of \$56,250, or a grand total for canal of \$517,050.

It will be necessary to do more or less paving where the ledge does not extend above the water surface to protect the slopes from the wash of passing boats, but this cost would probably not exceed \$2,000.

No estimate is given of excavation chargeable to the cost of locks and dam, as it has been included in the report of the consulting engineer, nor for that below the entrance of the lock at Ward Hill, as it is assumed that the United States Government will provide a channel to that point.

On account of insufficient data it is not possible at the present time to make a reliable estimate of the cost of maintaining a depth of 18 feet in the channel.

Summary.

Distance from turning basin at Hunts Falls to Lawrence	
Dam-----	miles-- 8.8
Distance from dam to entrance of canal-----	do---- 5.7
Distance across Ward Hill Canal, river to river-----	mile-- .8
Total distance covered by work-----	miles-- 15.3
Total number borings in river channel-----	151
Total linear feet (successful borings) in river-----	1, 338
Total number borings across Ward Hill-----	27
Total linear feet across Ward Hill-----	315
Total linear feet of borings-----	1, 653

Excavation:

Above Lawrence Dam—

Channel and turning basin, 1,620,000 cubic yards, at 35 cents-----	\$567, 000
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Below Lawrence Dam—

To entrance canal, earth, 3,271,000 cubic yards, at 45 cents-----	\$1, 471, 950
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To entrance canal, rock, 40,000 cubic yards, at \$7-----	280, 000
--	----------

	1, 751, 950
--	-------------

Canal to lock, rock, 384,000 cubic yards, at \$1.20---	460, 800
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Canal to lock, earth, 225,000 cubic yards, at 25 cents--	56, 250
--	---------

	517, 050
--	----------

Paving slopes-----	2, 000
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	2, 838, 000
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Engineering and contingencies, at 20 per cent-----	567, 600
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Total-----	3, 405, 600
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Very respectfully,

Geo. W. Wood, *Engineer*.

DECEMBER 1, 1913.

REPORT OF EDWARD C. SHERMAN, CONSULTING ENGINEER.

GENTLEMEN: In accordance with your instructions I have made designs for the structures which would be required by a project to create a navigable channel in the Merrimack River from Lowell to tidewater near Ward Hill, and I have the honor to submit the following report on their purposes and probable costs:

General description.

The project for which the structures described herein are designed is based on the assumption that the Merrimack River is to be made navigable from the sea to a point opposite Ward Hill by providing a channel 18 feet deep at mean low water, under such plan of development as may be adopted by Congress and carried out by the War Department, and that the Commonwealth of Massachusetts is to prepare a project for a channel 18 feet deep from the point opposite Ward Hill to Lowell.

The proposed project would involve the construction of channels, locks, and dams as follows:

A channel would be dredged in the river from a point near Lowell to the dam at Lawrence to give a depth of 18 feet below the low-water level of the pool formed by the dam. At Lawrence a lock would be provided so that vessels could be passed by the dam into another channel not less than 18 feet deep, which would follow the river to a point just above Kimballs Island, where it would enter the proposed Ward Hill Canal, a direct cut-off around Mitchells Falls, to the channel, which, it is assumed, the United States will provide in the tidal section of the river.

Just below Kimballs Island a dam would be constructed to hold back the water and form a pool at the highest level possible without interfering with the flow from the water wheels at Lawrence, so as to reduce to a minimum the amount of excavation necessary for the channel.

The surface of this pool would always be several feet higher than the water surface in the river below Mitchells Falls. Consequently a lock would be provided at the north end of the Ward Hill Canal by which vessels would pass from one level to the other.

Dimensions of locks.

As you have determined on 18 feet as the depth of the proposed navigable channel, the dimensions which I have adopted for the locks are fixed by the lengths and widths of such vessels as can navigate in a channel of that depth.

A careful study has been made of lists giving the dimensions of all vessels navigating the Atlantic coast, and it appears that, while the great majority of those which may be expected to use the river are from 140 to 190 feet long, and seldom more than 36 feet wide, there are nevertheless a very considerable

and increasing number of coasting vessels of from 15 feet to 17.5 feet draft which are about 250 feet long and up to about 43 feet wide.

In designing the locks additional allowance must be made for a towboat, since only a part of those vessels could navigate a comparatively narrow and crooked channel under their own power. The proper lock dimensions have consequently been determined to be as follows:

	Feet.
Usable length-----	350
Width -----	45
Depth at gate sill-----	18

Lock and changes in dam and in bridges at Lawrence.

Lock.—The entire difference between the water levels at Lawrence can best be overcome by one lock having a lift of about 35 feet at normal stages of the river. It would be located along the northerly bank of the river, as shown on sheet No. 1 of the plans accompanying this report.

The lock gates would be of the mitering, girder type, built of steel and having oak quoin and meeting posts. The upper gates would be 27 feet high and the intermediate and lower gates about 59 feet high. It is proposed to operate them by the method which has been adopted on the Panama Canal—that is, by means of a strut, one end of which is attached to the gate, the other to the rim of a “bull wheel” contained in a chamber in the lock wall and driven by an electric motor.

The filling culverts, one in each side wall, would run the entire length of the lock, filling and emptying the lock chamber being accomplished through ports near the lock floor. The flow in the culverts would be controlled by sluice-gates at the ends.

In order to avoid the danger of the lower lock-gates being rammed by a vessel, a heavy steel buffer beam is proposed. The presence of such a beam would require a vessel to stop some distance away from the gates, and if it were not stopped it is improbable that after destroying the buffer it would retain enough momentum to cause serious damage to the gates.

At the upper end of the lock the drawbridge will provide sufficient protection to the gates and the buffer beam can be omitted.

The possibility exists that, in spite of all precautions, an accident may happen by which one pair of gates would be destroyed while the others were open, permitting an unobstructed flow of water through the lock from the upper to the lower level. It is therefore proposed to make the drawbridge serve as an “emergency dam,” the lower chords forming a horizontal truss which could support the upper ends of steel girders, which, lowered into the lock, would provide supports for wickets by which the flow could be checked without emptying the pool above the dam.

Practically the entire normal flow of the river is used for power purposes at Lawrence, so that no more water should be taken for lockages than becomes absolutely necessary. Consequently, although the total usable length of the lock would be 350 feet, it is proposed to divide that length into two chambers about 110 feet and 240 feet long by means of intermediate gates, so that, for any vessel, a lock chamber of suitable length may be provided and unnecessary waste of water avoided.

It is probable that a large part of the traffic will be vessels in tow, and that the towboats, after delivering them at their quays, will return downstream alone. A very considerable saving in water will result from the use of the 110-foot chamber by such craft.

Locks for small boats.—In addition to the commercial traffic, it is expected that a very large number of power boats and other small craft will use the improved river. As it is not desirable that even the 110-foot chamber of the large lock be used for such boats on account of the need of conserving the water supply, it is proposed to provide a flight of two small locks adjacent to the large one. These locks would be about 50 feet long, 10 feet wide, and 5 feet deep at low water.

Water levels at Lawrence.—The difference in the levels of the pools above and below the Lawrence Dam will vary somewhat with the stage of the river and the storage conditions. The stone crest of the dam is at elevation 34.12, but the water is ordinarily held several feet higher by means of flashboards. The pool seldom, if ever, falls below elevation 36.0, nor has it ever been higher

than elevation 44.0. The ordinary water level may be assumed to be at about elevation 39.0.

With these data the upper approach wall and the lock walls are fixed at elevation 45.0, so that they may never be overtopped by the water, and the upper sill is fixed at 18 feet below elevation 36.0, at elevation 18.0.

The proper elevation for the lower sill of the Lawrence lock is a problem which can be accurately determined only by more complete study than is justified by the purposes of this report.

It is not permissible that the pool level be higher than elevation 5.48 at Lawrence when the river discharge is less than about 4,000 cubic feet per second on account of interference with the existing power interests. Assuming that with that discharge the slope of the water surface to Ward Hill, which is now about 9 inches to the mile, will be about 9 inches in the whole distance after the channel is improved by dredging, the water surface at the lower end of the pool would be at about elevation 4.7.

If the discharge of 4,000 cubic feet per second were constant, a fixed masonry dam could perhaps be built at Kimballs Island to create a pool at this elevation, but as the water must not be backed up at Lawrence for any given discharge to a height greater than obtains at present, it is assumed that a movable dam, affording complete regulation of the flow, will be used.

It appears that when the mills at Lawrence shut down on Saturday afternoon and are closed over Sunday and sometimes over Monday when a holiday happens to come on that day, the whole discharge of the stream is frequently stored at the Lawrence Dam, and the flow in the river channel is almost nothing. The leakage past the movable dam during such a period would be considerable and would result in a lowering of the pool level by an amount which, until the dam is designed, is indeterminate.

Believing that the lowering might amount to about a foot before a new supply would begin to refill the pool, it has been assumed for the purposes of the designs that low water would be at elevation 3.7. Accordingly, the lower sill and the bottom of the lock are placed at elevation -14.3 to give the desired depth of 18 feet.

Changes at Lawrence Dam.—The Lawrence Dam has a length on its crest of 897 feet. Although it is proposed to extend it about 175 feet at the south end, the total length would be reduced to about 875 feet by the construction of the locks. As this reduction in length would cause a great freshet, equal to that of 1896, to back up to an additional height of only about 3 inches, it is not considered impracticable.

The changes required above the dam would be slight and would consist in excavating a new entrance to the north power canal and in such changes at the south power canal as the extensions of the dam render necessary.

The waterway below the dam is at present much obstructed by bridge piers. As the lock will further restrict the available area, it is proposed to excavate a channel in the rock of sufficient cross section to compensate for this restriction and further to improve the conditions by removing the Broadway Bridge entirely, placing the highway on a new, double-deck structure on the site of the present Boston & Maine Railroad Bridge, which would serve for both highway and railroad. This arrangement offers the great advantage of requiring but one drawbridge over the lock, and incidentally affords an excellent opportunity to eliminate the dangerous grade crossing which now exists near the north end of the bridge.

The changes which would be required in the other bridges are minor ones and consist principally in the introduction of suitable bascule drawbridges.

Cost.—It is estimated that the cost of the work at Lawrence, exclusive of such excavation as is chargeable to ship channels in the river, of the removal of the Broadway Bridge, of the proposed new combination bridge, and the changes in the other bridges, will be about \$921,000.

The details of this estimate are given in an appendix to this report.

Locks and power plant at Ward Hill.

Ship lock.—The proposed Ward Hill Canal has been laid out to take advantage of the topography of the country through which it passes, and its direction at the north end is such that vessels must make a turn of nearly 90 degrees to enter the river channel. On account of the current in the river, this turn can best be made in a basin just above the lock, which, to avoid heavy excavation, is placed near and parallel to the river bank, as shown by the location on sheet No. 3 of the plans accompanying this report.

The details of the proposed lock, also shown on sheet No. 3, do not differ materially from those of the Lawrence Lock previously described, except that the lift is made to fit the conditions that would be met. The intermediate gates are omitted, since the quantity of water used for lockages would not be taken from a supply intended for power, and the time lost in filling a lock chamber longer than would always be necessary would be little on account of the low lift.

The upper sill is shown placed at elevation —14.3, which is the same as the lower sill at Lawrence, and the lower sill and floor of the lock are placed at elevation —22.8, which is 18 feet below mean low tide at this point. The lift wall would therefore be 8.5 feet high, but the actual lift for vessels will vary from that somewhat with the different stages of the river and of the tide.

Small-boat lock.—Although the water supply would permit the use of the large lock by small boats, it is advisable to consider the advantages of a separate small lock for such craft on account of the saving in time. Such a lock is shown on the plan, leading from the westerly side of the turning basin to the river.

Power plant.—The difference in level between the Ward Hill Canal and the river near the proposed lock will ordinarily vary from about 3.5 feet to about 10 feet, depending on the stages of the river and the tide. It is probable that an average difference of about 7 feet will exist, and it may be found advantageous to install a plant to develop the power necessary for the operation of the locks at Ward Hill and at Lawrence, to light the canal and the navigable river channels, and possibly to pump back, over the dam at Lawrence, an amount of water equal to that used there in lockages so as to fully compensate the owners of the power rights.

It is possible that the uncertainty as to the quantity of water that would be available for power development on Sundays and holidays will render the project inadvisable.

Owing to lack of time this matter has not been thoroughly studied, but the possibility of power development should receive consideration in any actual improvement.

Cost.—It is estimated that the cost of the work at Ward Hill, including the excavation for the turning basin but exclusive of cost of site, will be about \$807,000. The details of this estimate are given in an appendix to this report.

DAM NEAR KIMBALLS ISLAND.

As explained elsewhere in this report, it is important that the dam which forms the pool from Lawrence to Ward Hill be constructed so as to offer little obstruction to the flood flow of the stream, since, for any given discharge, the water can not be permitted to back up to a higher elevation at Lawrence than it does now. At the same time a reasonably tight dam, with its crest at about elevation 4.5, should be available during times of low flow.

There are a number of types of movable dam which have been found successful in practice. The simplest type consists merely of stop planks put in place and removed as required. Sliding gates were evolved from stop planks, and these have been developed in various ways. One form, known as Stoney gates, has been built to close openings up to 45 feet wide.

Owing to the very considerable rise of the river in time of flood, and to the presence of ice floes in the spring, the most satisfactory dam would be one of those which fold down on the bottom of the stream. It must be easily operated, free from complicated mechanism, and so strong and simple that ice can not damage it, and should be capable of being lowered rapidly without chance of failure.

As the various forms of wicket dams which would satisfy these conditions are not easily made tight, and as the proposed pool would have to be maintained on days when the river discharge is practically nothing, it is probable that a dam of the bear-trap type would best serve the purpose.

It is therefore tentatively proposed to construct a dam across the river at a point about 1,700 feet below the lower end of Kimballs Island. The stream is about 400 feet wide at that point, and the proposed dam would consist of four bear straps, each about 90 feet long, set between permanent masonry end abutments and three river piers. The piers would also provide supports for a combination highway and service bridge.

No design has been made for this dam as it would require much more time than has been available, but from sketches it has been roughly estimated to cost about \$310,000.

Conclusions.

The design and construction of the dam and locks, and the changes in existing structures at Lawrence, which would be necessary to the execution of your project for making the Merrimack River navigable from Lowell to tidewater near Ward Hill, would involve no unusual engineering problems, although there are many points which would require careful and thorough investigation.

It is believed that the results obtained are sufficiently accurate for the purpose of determining the practicability of the project.

Respectfully submitted.

EDWARD C. SHERMAN,
Consulting Engineer.

NOVEMBER 19, 1913.

APPENDIX.

The details of the estimate of cost of the work at Lawrence are tabulated below:

Excavation for canal approaches, 20,000 cubic yards, at \$0.40-----	\$8, 000
Excavation for extension of dam, 52,500 cubic yards, at \$0.75-----	39, 400
Dry excavation in rock below dam for channels, 20,300 cubic yards, at \$2.50-----	50, 800
Removal of part of Lawrence Dam at lock, 1,140 cubic yards, at \$1.75--	2, 000
Dry excavation in rock for chamber of lock, 23,400 cubic yards, at \$2.50 -----	58, 500
Approach walls at ends of lock:	
Concrete, 6,400 cubic yards, at \$7-----	\$44, 800
Riprap (from excavation), 1,480 cubic yards, at \$0.65---	1, 000
Spruce piles, 46,700 linear feet, at \$0.22-----	10, 300
Yellow-pine pile caps, 44 M feet, at \$100-----	4, 400
Spruce plank, 38 M feet, at \$90-----	3, 400
	63, 900
Wall at south end of Lawrence Dam, 4,900 cubic yards, at \$6.50-----	31, 900
Cofferdam, south end of Lawrence Dam, 340 linear feet, at \$25-----	8, 500
Round piles, at \$0.25 per linear foot.	
Wales, at \$125 per M feet.	
Sheet piling, at \$70 per M feet.	
Steel rods, at \$0.10 per pound.	
Filling, at \$0.60 per cubic yard.	
Removing structures, at \$6.67 per linear foot.	
Extension of Lawrence Dam, 2,800 cubic yards, at \$7-----	19, 600
Cofferdam around lock:	
220 linear feet, at \$43.50-----	\$9, 600
110 linear feet, at \$25-----	2, 700
880 linear feet, at \$56-----	49, 200
	61, 500
Round piles, at \$0.25 per linear foot.	
Wales, submerged, at \$120 per M feet.	
Sheeting, at \$80 per M feet.	
Steel rods, submerged, at \$0.10 per pound.	
Steel rods, at \$0.06 per pound.	
Filling, at \$0.60 per cubic yard.	
Gravel embankment, at \$0.50 per cubic yard.	
Framed lumber, at \$90 per M feet.	
Removal, at \$10 to \$14 per linear foot.	
Lock masonry:	
Concrete—	
1:2½:5, 38,460 cubic yards, at \$7.50-----	\$288, 500
Cyclopean, 1,400 cubic yards, at \$5-----	7, 000
Granolithic surfacing, 2,320 square yards, at \$1.08-----	2, 500
	\$298, 000
Lock gates—	
Steel, 700,000 pounds, at \$0.055-----	38, 500
Other materials-----	6, 500
	45, 000
Metal set in concrete—	
Cast iron, 260,000 pounds, at \$0.04-----	10, 400
Structural steel, 12,00 pounds, at \$0.05-----	600
Reinforcing rods, 40,000 pounds, at \$0.035-----	1, 400
	12, 400

Lock masonry--Continued.

Buffer beam, 33,000 pounds, at \$0.045-----	\$1, 500
Wicket girders and wickets, 130,000 pounds, at \$0.05-----	6, 500
Sluice gates, motors, controllers, installations, at about \$50 per square foot of opening-----	19, 000
Booms-----	2, 000
Steel booms, floats, at \$0.04 per pound.	
Chain, at \$0.04 per pound.	
Concrete anchors, at \$15 per cubic yard.	
Timber booms, at \$0.15 per linear foot.	
Anchors, at \$5 each.	
Operating building-----	8, 000
12-inch pump, motor, and piping for pumping water back above dam-----	4, 000
Lock-gate operating machines, 6 at \$3,200 each, say-----	19, 000
Electrical equipment--	
Wiring-----	\$1, 000
Switchboard-----	1, 000
	2, 000
Small boat-lock equipment--	
Lock gates-----	4, 000
Operating machines and motors-----	2, 000
	6, 000
	767, 500
Engineering and contingencies, 20 per cent-----	153, 500
Total-----	921, 000

This estimate does not include excavation chargeable to channel in river, removal of Broadway bridge, and changes in other bridges.

The details of the estimate of cost of the turning basin, locks, and power plant at Ward Hill are tabulated below:

(a) Turning basin:

Dry-earth excavation, 80,000 cubic yards, at \$0.50-----	\$40, 000
Dry-rock excavation, 91,000 cubic yards, at \$1.10-----	100, 000

(b) Locks:

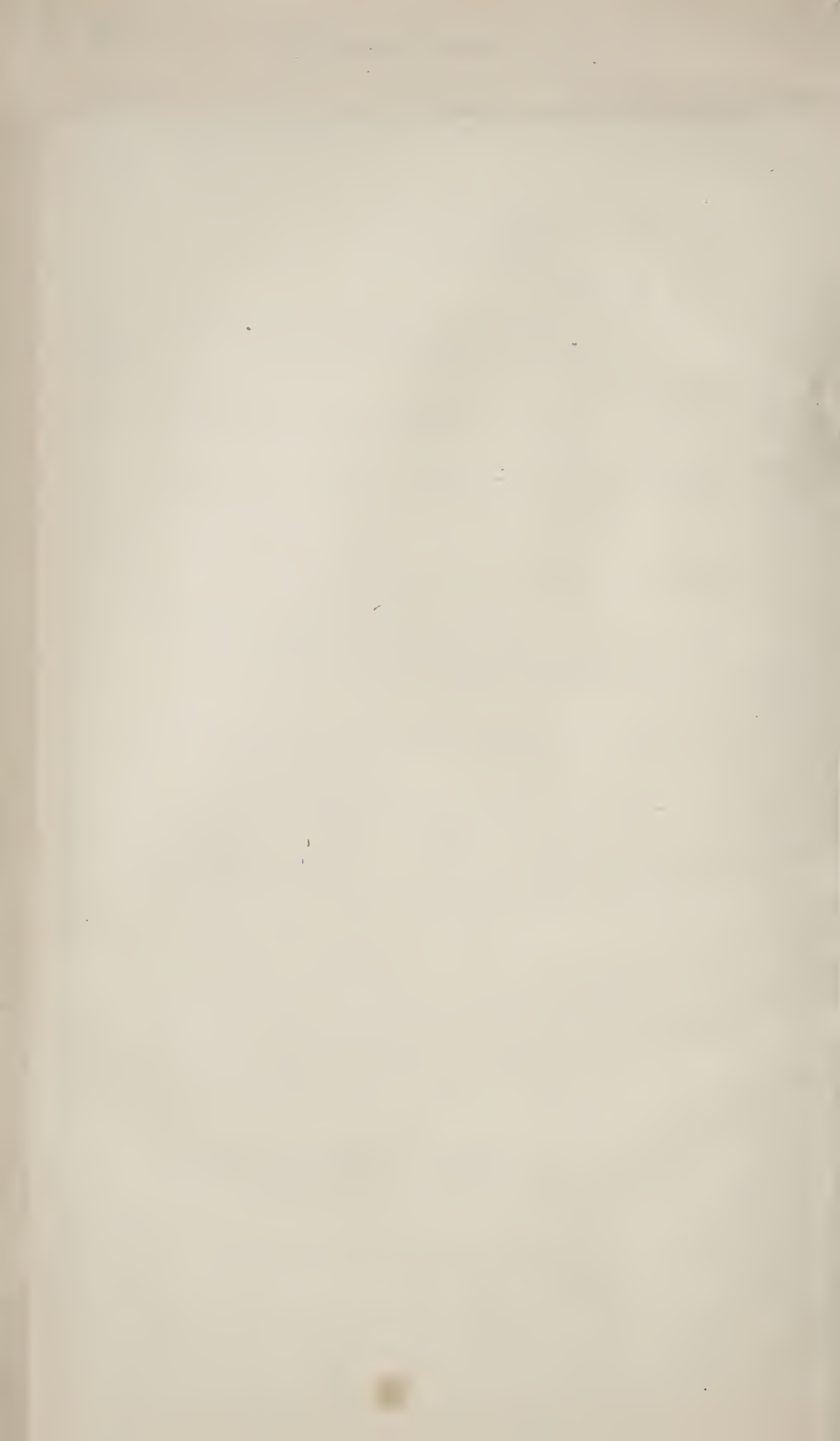
Dry-earth excavation, 77,000 cubic yards, at \$0.50-----	38, 500
Wet-earth excavation, 13,000 cubic yards, at \$0.75-----	12, 900
Dry-rock excavation, 23,000 cubic yards, at \$1.10-----	25, 000
Wet-rock excavation, 6,000 cubic yards, at \$2.50-----	15, 000
Cofferdam, 730 linear feet, at \$40-----	29, 200
Concrete masonry, 41,000 cubic yards, at \$7.50-----	308, 000
Granolithic surfacing, 2,000 square yards, at \$1-----	2, 000
Lock gates-----	20, 000
Lock-gate operating machine-----	12, 800
Sluice gates and machinery-----	13, 000
Metal to be set in concrete--	
Cast iron, 130,000 pounds, at \$0.04-----	5, 200
Steel, 10,000 pounds, at \$0.05-----	500
Buffer beams, 66,000 pounds, at \$0.04½-----	3, 000
Operating building-----	5, 000
24-inch pump and motor-----	5, 000
Switchboard and wiring-----	2, 000
Equipment for small lock-----	4, 000

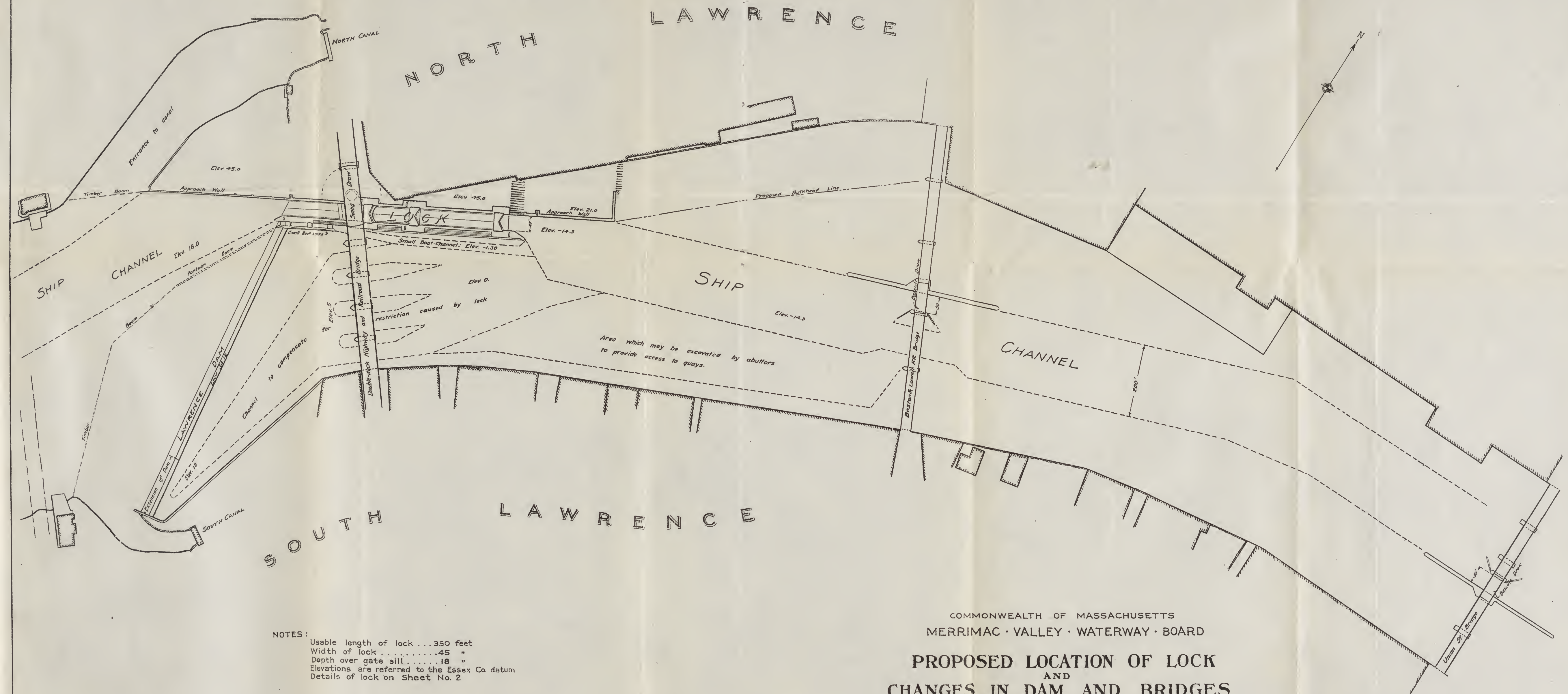
(c) Power plant:

Flume excavation, 6,000 cubic yards, at \$0.50-----	3, 000
Concrete masonry, 2,500 cubic yards, at \$7.50-----	18, 800
Superstructure-----	5, 000
Equipment-----	5, 300

	672, 300
Add 20 per cent for contingencies-----	134, 700

Total-----	807, 000
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NOTES:
 Usable length of lock ... 350 feet
 Width of lock 45 "
 Depth over gate sill 18 "
 Elevations are referred to the Essex Co. datum
 Details of lock on Sheet No. 2

COMMONWEALTH OF MASSACHUSETTS
 MERRIMAC · VALLEY · WATERWAY · BOARD

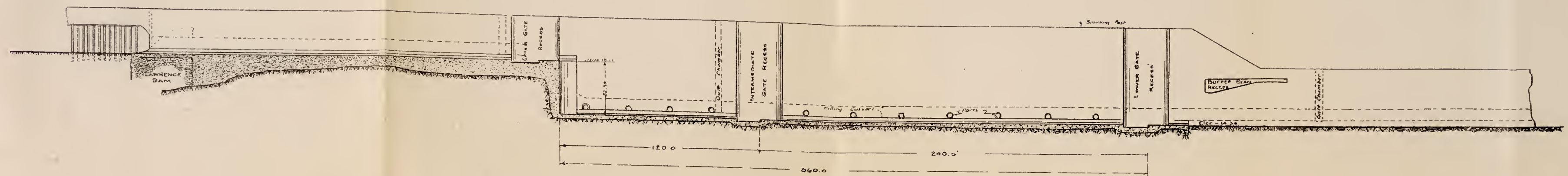
PROPOSED LOCATION OF LOCK AND CHANGES IN DAM AND BRIDGES AT LAWRENCE

0 50 100 200 FEET

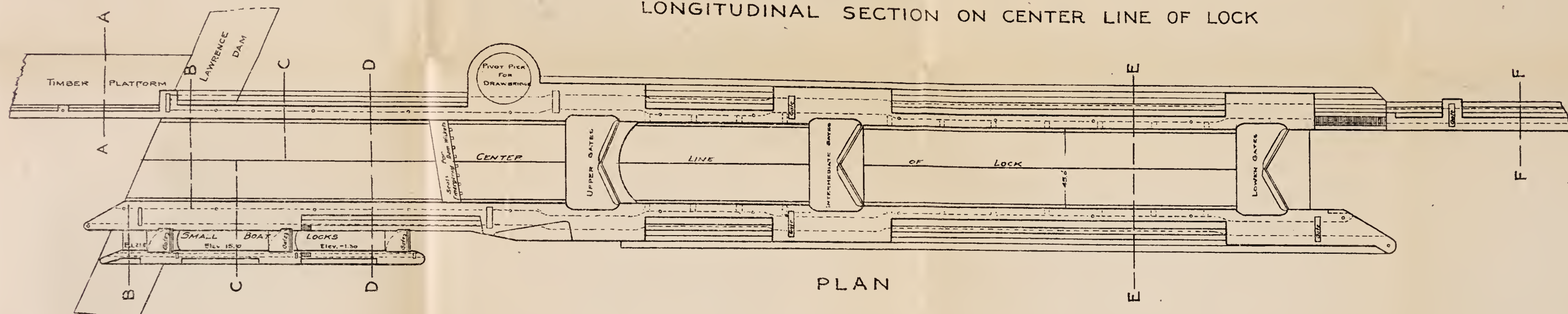
NOVEMBER 19, 1913

EDWARD C. SHERMAN
 CONSULTING ENGINEER
 6 BEACON ST., BOSTON

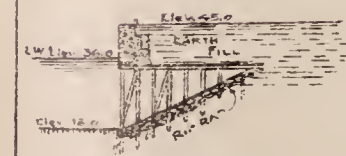
31
 15017



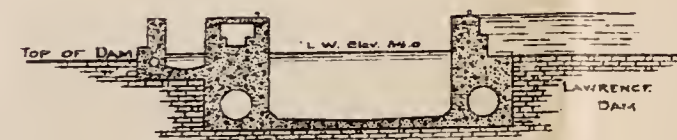
LONGITUDINAL SECTION ON CENTER LINE OF LOCK



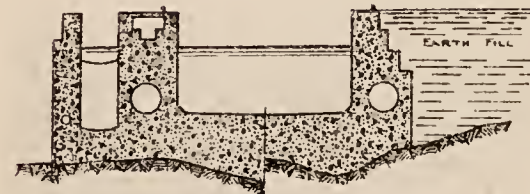
PLAN



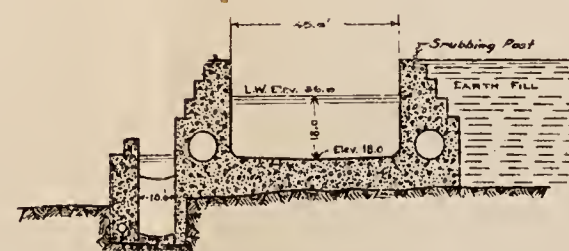
SECTION A-A



SECTION B-B



SECTION C-C



SECTION D-D



SECTION E-E



SECTION F-F

NOTE:
Elevations are referred to the Essex Co. datum.
For location see Sheet No. 1

COMMONWEALTH OF MASSACHUSETTS
MERRIMAC · VALLEY · WATERWAY BOARD
PLAN AND SECTIONS
OF
PROPOSED LOCK AT LAWRENCE

0 10 20 30 40 50 60 70 80 90 100 FEET

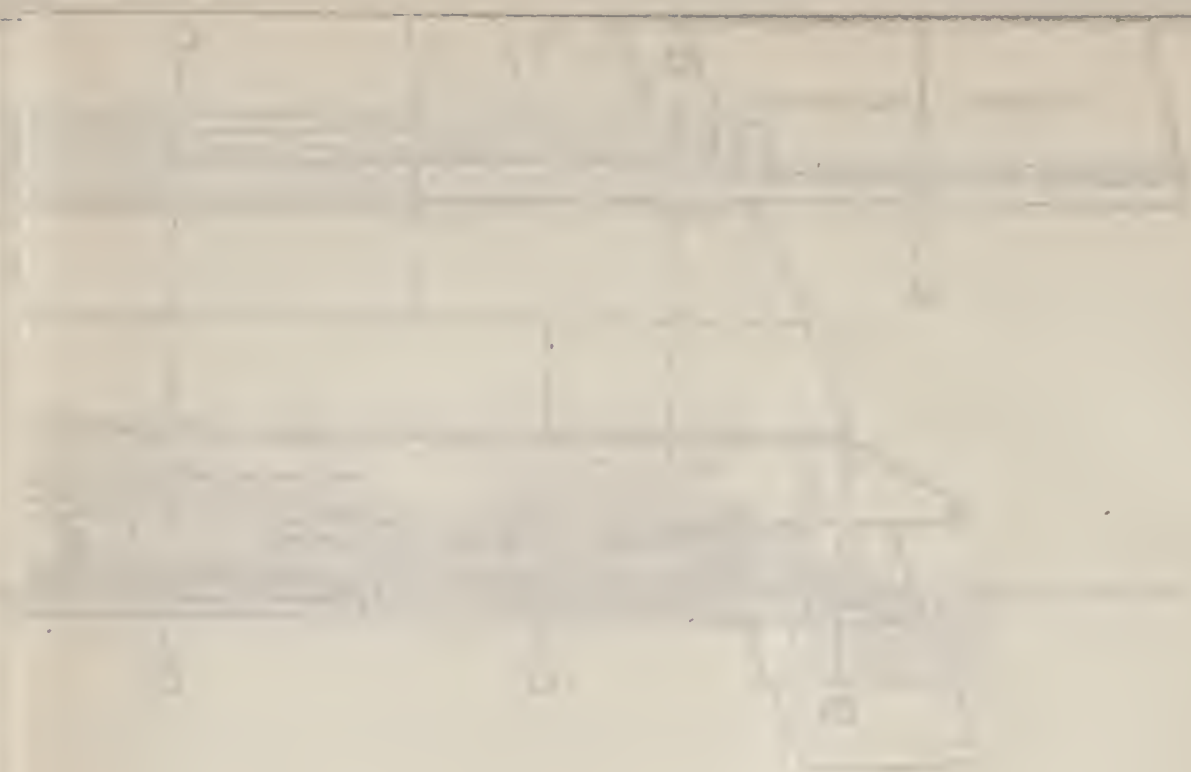
NOVEMBER 19, 1913

EDWARD C. SHERMAN
CONSULTING ENGINEER
6 BEACON ST. BOSTON

32
6501.2

House Doc. No. 1813 ; 64th Cong., 2d Sess.

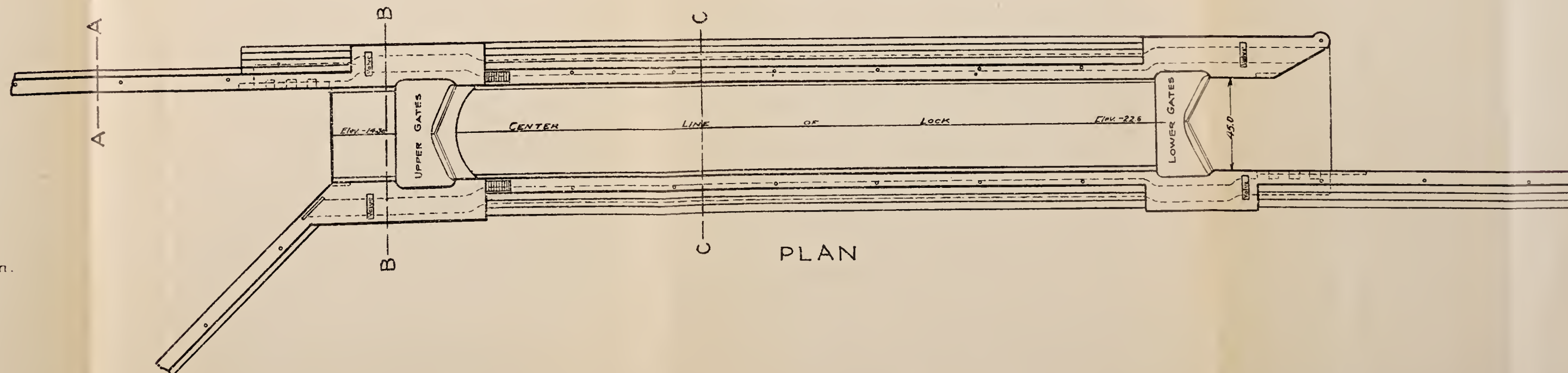
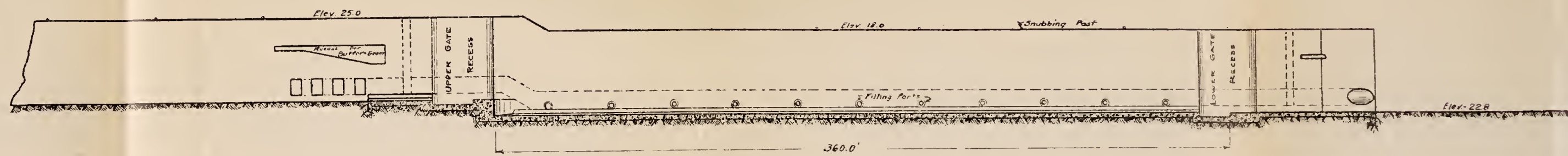
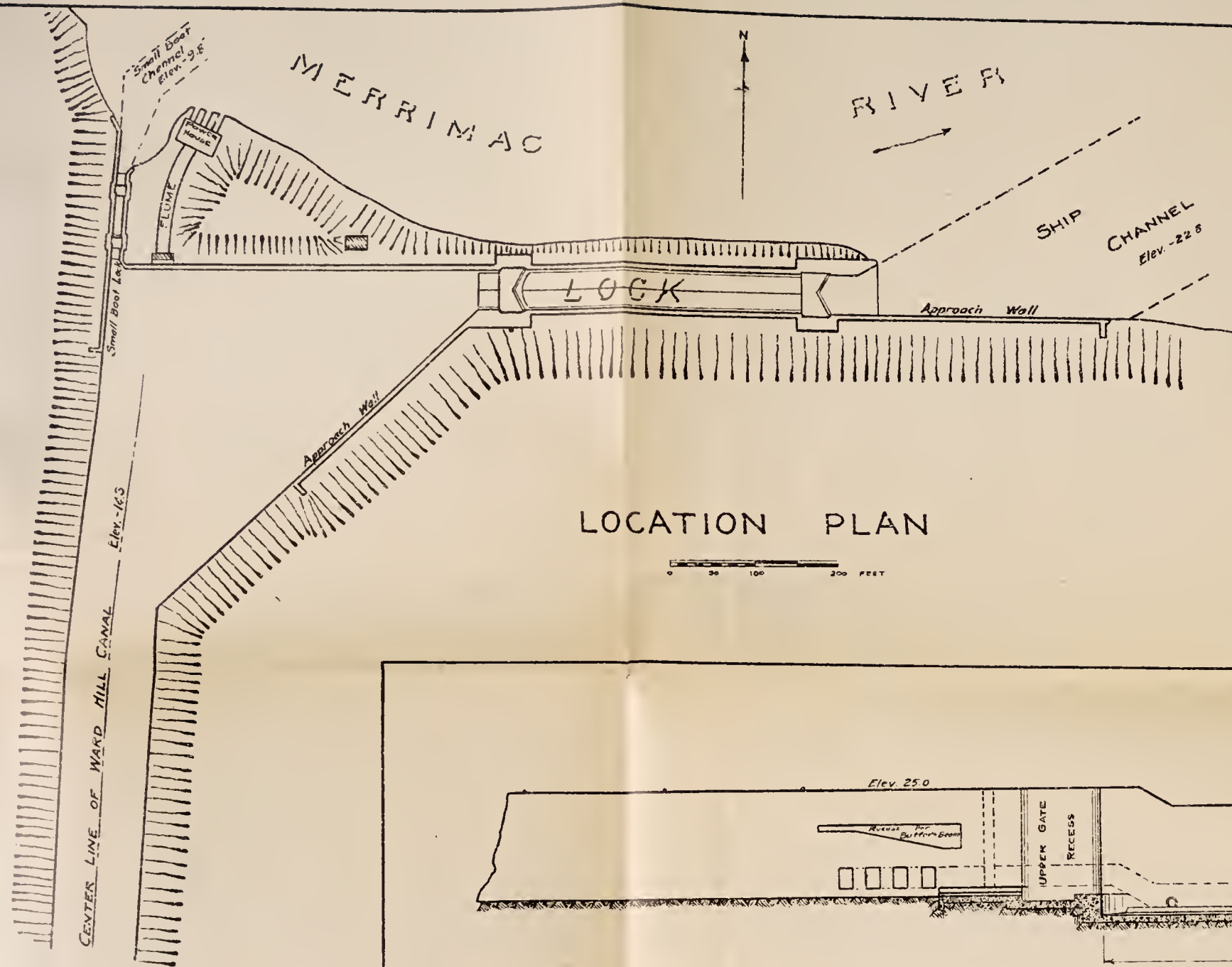
Sheet No. 2



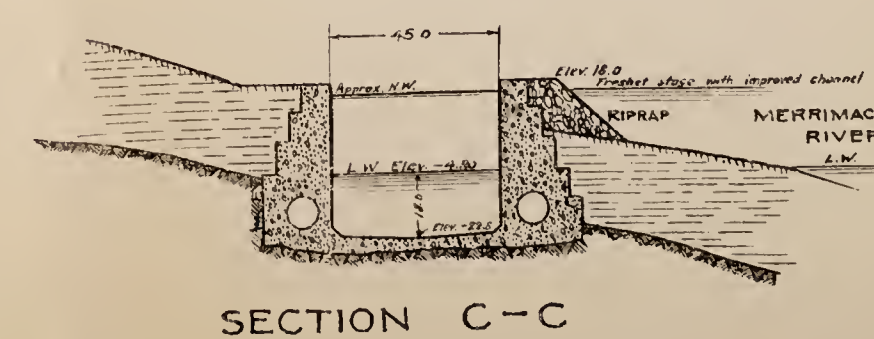
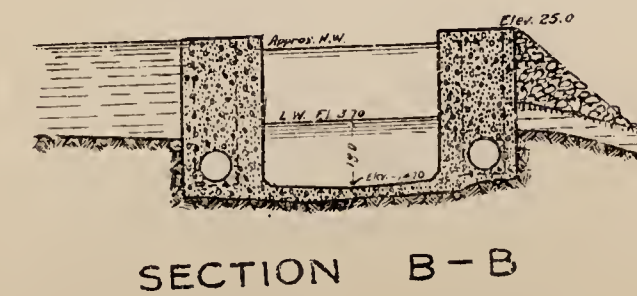
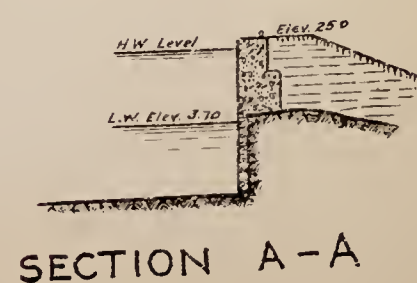
SECTION B-B

SECTION A-A

NOTES: 1. All dimensions are in inches. 2. All surfaces are to be finished. 3. All parts are to be made of steel.



NOTE:
 Usable length of lock 350 feet
 Width of lock 45 "
 Depth over gate sill 18 "
 Elevations are referred to the Essex Co datum.



COMMONWEALTH OF MASSACHUSETTS
 MERRIMAC · VALLEY · WATERWAY · BOARD

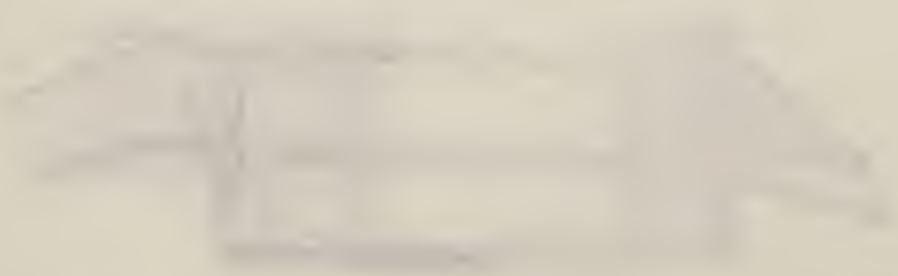
WARD HILL LOCK

NOVEMBER 19, 1913

EDWARD C. SHERMAN
 CONSULTING ENGINEER
 6 BEACON ST., BOSTON

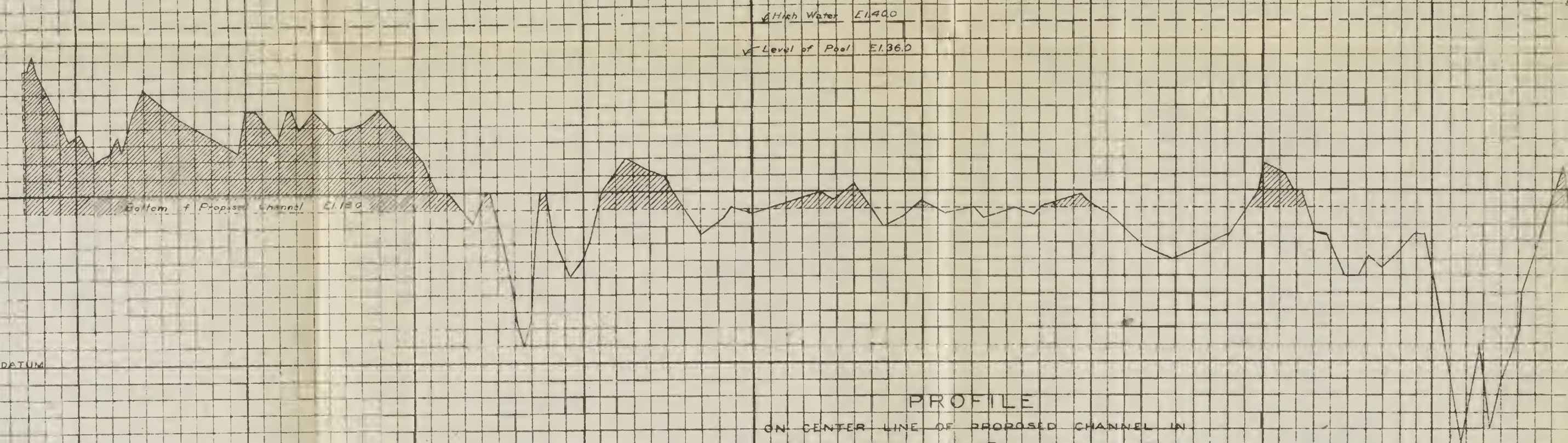


1897
The following are the names of the persons who have been
admitted to the office of the Secretary of the Board of
Education since the last meeting of the Board.



A. A. HAYES

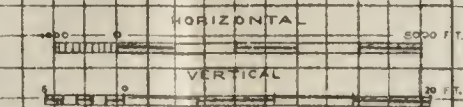
HUNT'S FALLS
ESSEX CO. DATUM



PROFILE
ON CENTER LINE OF PROPOSED CHANNEL IN
MERRIMAC RIVER
WARD HILL TO HUNT'S FALLS
PREPARED UNDER DIRECTION OF THE
MERRIMAC VALLEY WATERWAY BOARD
ESTABLISHED BY CHAP. 708 ACTS OF 1912

JAN. 1914

SCALES



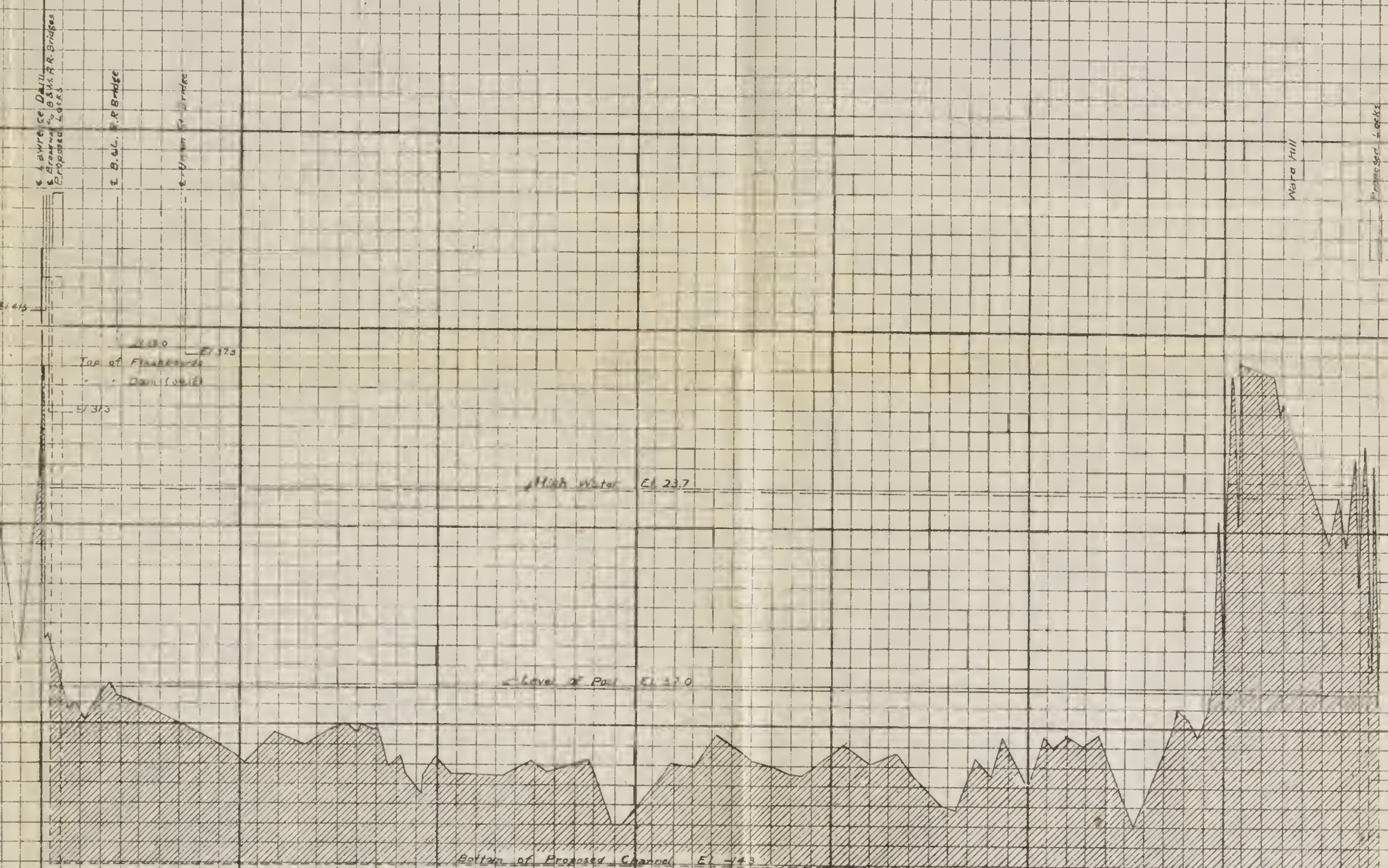
CHARLES C. PAINE, Chairman
ANDREW B. SUTHERLAND
LEWIS R. HOVEY

MERRIMAC VALLEY
WATERWAY BOARD

GEORGE W. WOOD, Engineer
EDWARD J. SHAW, Consulting Engineer
and JACQUES J. B. DELAUNAY

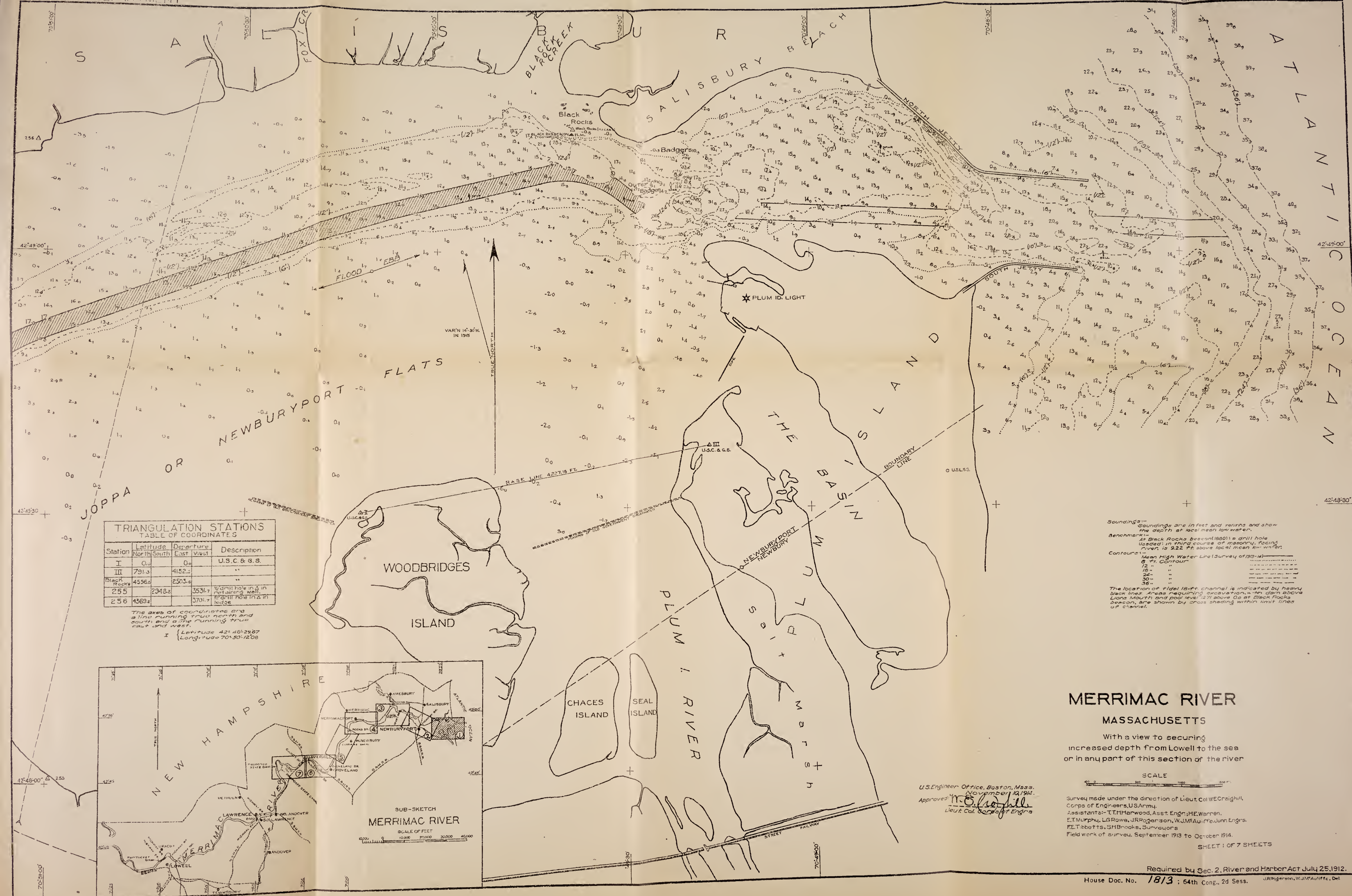
NOTE

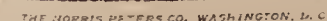
Datum used is Essex Co. base which is
3.12 ft. below crest of Lawrence Dam.
Crest of dam is 3.5 ft. above Mean Low
Water at Black Rock, Newburyport.



High Water El. 153+
Low Water El. 40
Bottom of Proposed Channel
ESSEX CO. DATUM







TRIANGULATION STATIONS
TABLE OF COORDINATES

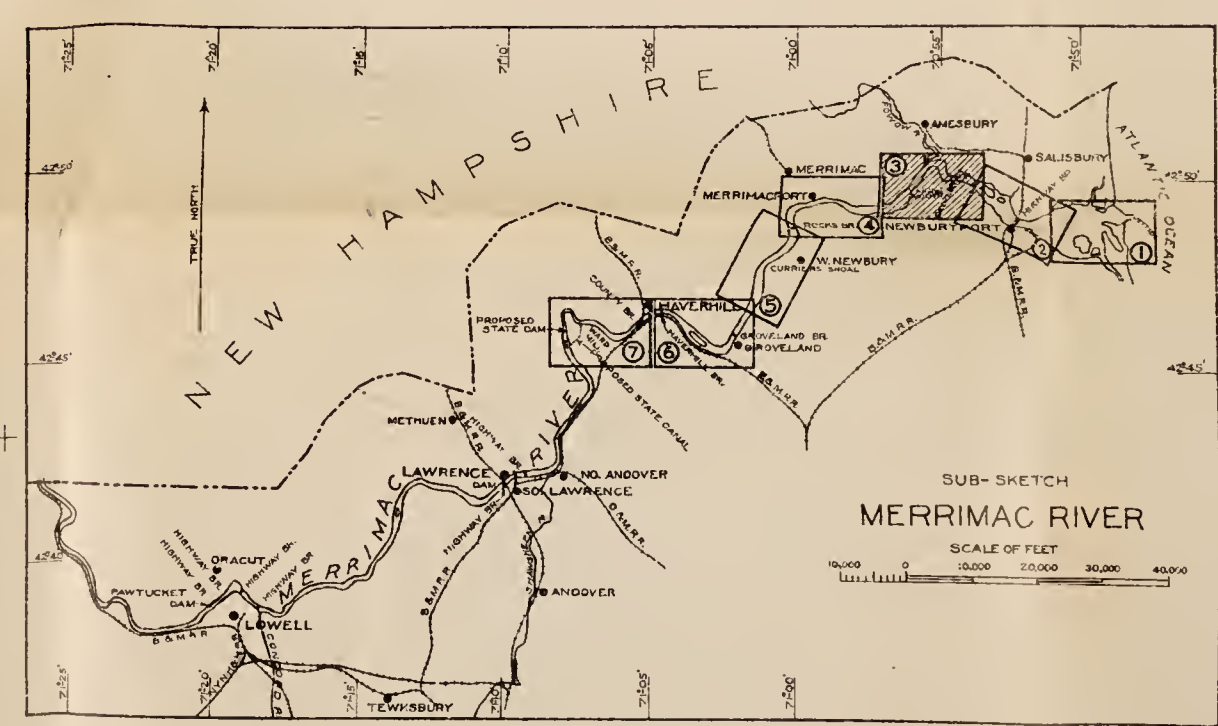
Station	Latitude North South	Departure East West	Description
226	00	00	1/2" drill hole in stone mon. marked A.C.N.S.
27A	66663	109216	1/2" drill hole in stone mon. marked A.C.N.S.
33	47155	105873	1/2" drill hole in stone mon. marked A.C.N.S.
205	25149	75400	1/2" drill hole in stone mon. marked A.C.N.S.
214	15655	49721	Concrete post marked U.S.C.
223	13703	27158	1/2" drill hole in stone mon. marked A.C.N.S.
ΔY Woodholes	00	00	U.S.C. & G.S. Δ
233	76843	154324	1/2" drill hole in stone mon. marked A.C.N.S.

The axes of coordinates are
a line running true north and
south and a line running true
east and west.

226 (Latitude 42°50'16.46") Mass. H. & L. Comm.
Longitude 70°52'12.46"
2 (Latitude 42°48'29.87")
Longitude 70°50'12.08"

Δ
Lone Tree
(U.S.C. & G.S.)

NEWBURY

MERRIMAC RIVER
MASSACHUSETTS

With a view to securing
increased depth from Lowell to the sea
or in any part of this section of the river.

SCALE

U.S. Engineer Office, Boston, Mass.

Approved: *H. S. Hough*
Lieut. Col. Corps of Engs.

Survey made under the direction of Lieut. Col. Wechsung,
Corps of Engineers, U.S. Army.
Assistants: T. T. Hough, Asst. Engr., H. E. Warren,
E. T. Murphy, L. G. Rowe, J. R. Rogers, W. M. Auliffe, Junr., Engrs.
F. E. Tibbets, S. H. Brooks, Surveyors.
Field work of survey, September 1913 to October 1914.

SHEET 3 OF 7 SHEETS.

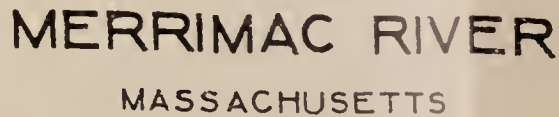
Required by Sec. 2, River and Harbor Act, July 25, 1912.

House Doc. No. 1813 64th Cong., 2d Sess.

J. R. Rogers, W. M. Auliffe, Del.

The axes of coordinates are
a line running true north and
south and a line running true
east and west.

Stevens 2	Latitude 42°48'57.39"
	Longitude 70°59'25.55"
	Latitude 42°50'02.95"
Lone Tree Hill 2	Longitude 70°56'46.52"



With a view to securing increased depth from Lowell to the sea or in any part of this section of the river

SCALE

Survey made under the direction of Lieut. Col. W. E. Craig, Jr.,
Corps of Engineers, U.S. Army.
Assistants - T. H. Woodward, Asst. Engr.; H. E. Warren,
E. T. Murphy, L. G. Rowe, J. R. Rogerson, W. M. Auliffe, Jr., Engrs.;
F. E. Tibbatts, S. H. Brooks, Surveyors.
Field work of Survey, September 1913 to October 1914.

SHEET 4 OF 7 SHEETS.

Required by Sec. 2, River and Harbor Act, July 25, 1912.

House Doc. No. 1813 : 64th Cong., 2d Sess. J. R. Rogerson, W. J. M. Auliffe, Del.

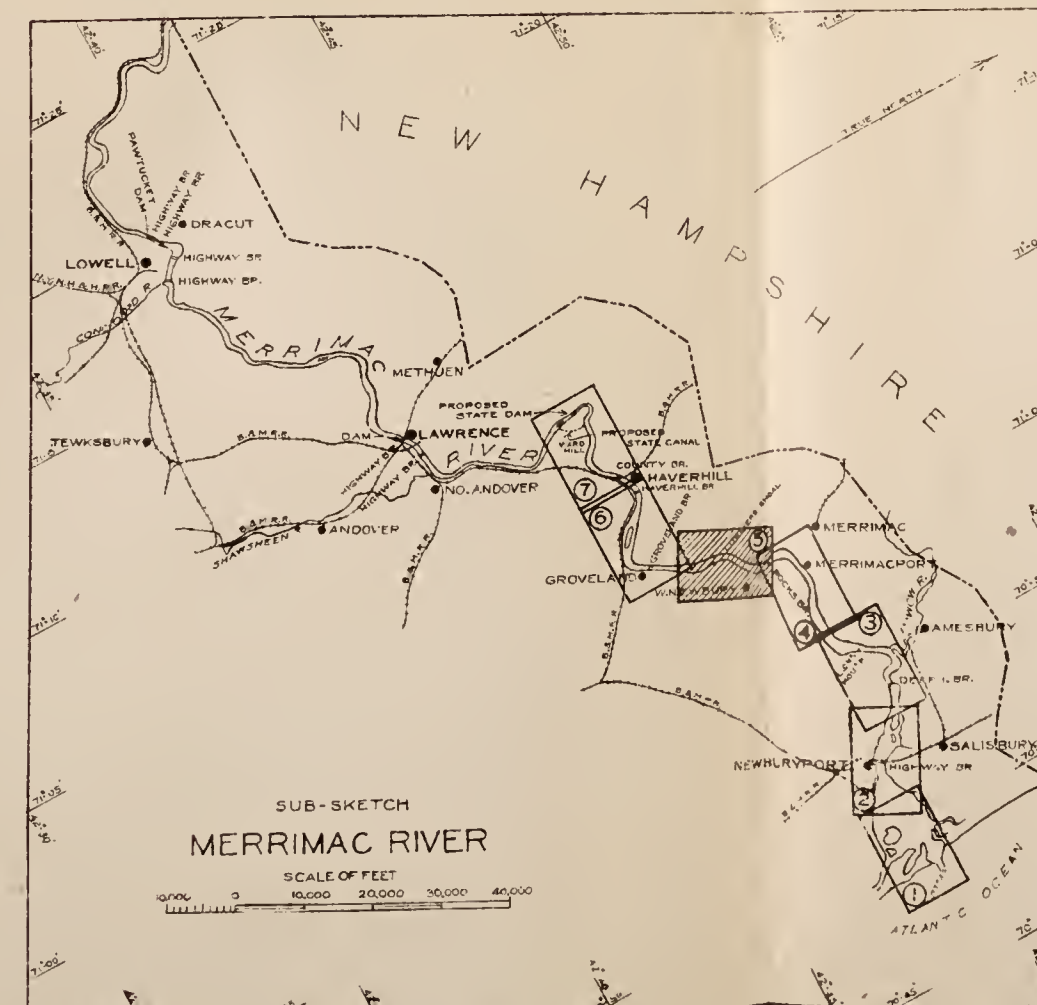
TRIANGULATION STATIONS				
TABLE OF COORDINATES				
Station	Latitude North	Latitude South	Departure East	Departure West
Stevens 2	00	00		
3	1103.9		3353.6	
38	3548.9		3090.8	
41	5207.1		2627.1	
42	5494.6		4689.7	
45	7379.1		5433.0	
46	7851.4		7575.1	
50	10577.8		8921.9	
51	9458.7		7348.6	
54A	13211.7		9207.6	
57	12136.8		7378.6	
63	14915.6		6005.4	

The axes of coordinates are a line running true north and south and a line running true east and west.
Stevens 2 Latitude 42°48'57.3" Longitude 70°53'25.5"



GROVELAND

Soundings:—
Soundings are in feet and tenths and show the depth at local mean low water.
Benchmarks:—
At Rocks Bridge (1903): 5/8 inch drill hole in triangle curb top course of masonry in downstream face of draw pier is 16.85 ft. above local mean low water and 1975 ft. above mean low water at Black Rock beach.
Contours:—
Mean High Water Line (Survey of 1908):—
6 ft. Contour
12 ft. Contour
18 ft. Contour (Rock)
The location of tidal limit is indicated by heavy black lines. Areas requiring excavation with dam above Lions Mouth and pool level 15.71 ft. above 00 at Black Rock beach are shown by cross shading within limit lines of channel.



SUB-SKETCH
MERRIMAC RIVER
SCALE OF FEET
0 10,000 20,000 30,000 40,000

MERRIMAC RIVER MASSACHUSETTS

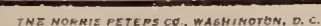
With a view to securing increased depth from Lowell to the sea or in any part of this section of the river.



U.S. Engineer Office, Boston, Mass.
November 10, 1914.
Approved: *W. O. Wright*
Lieut. Col. Corps of Engrs.

Survey made under the direction of Lieut. Col. W. E. Craighill, Corps of Engineers, U.S. Army.
Assistants: T. H. Harwood, Asst. Engr.; H. Warren, Asst. Engr.; E. T. Murphy, L. G. Rowe, J. R. Rogers, W. J. Muliffe, Junr., Engrs.; F. E. Tibbitts, S. H. Brooks, Surveyors.
Field work of survey, September 1913 to October 1914.

SHEET 5 OF 7 SHEETS.

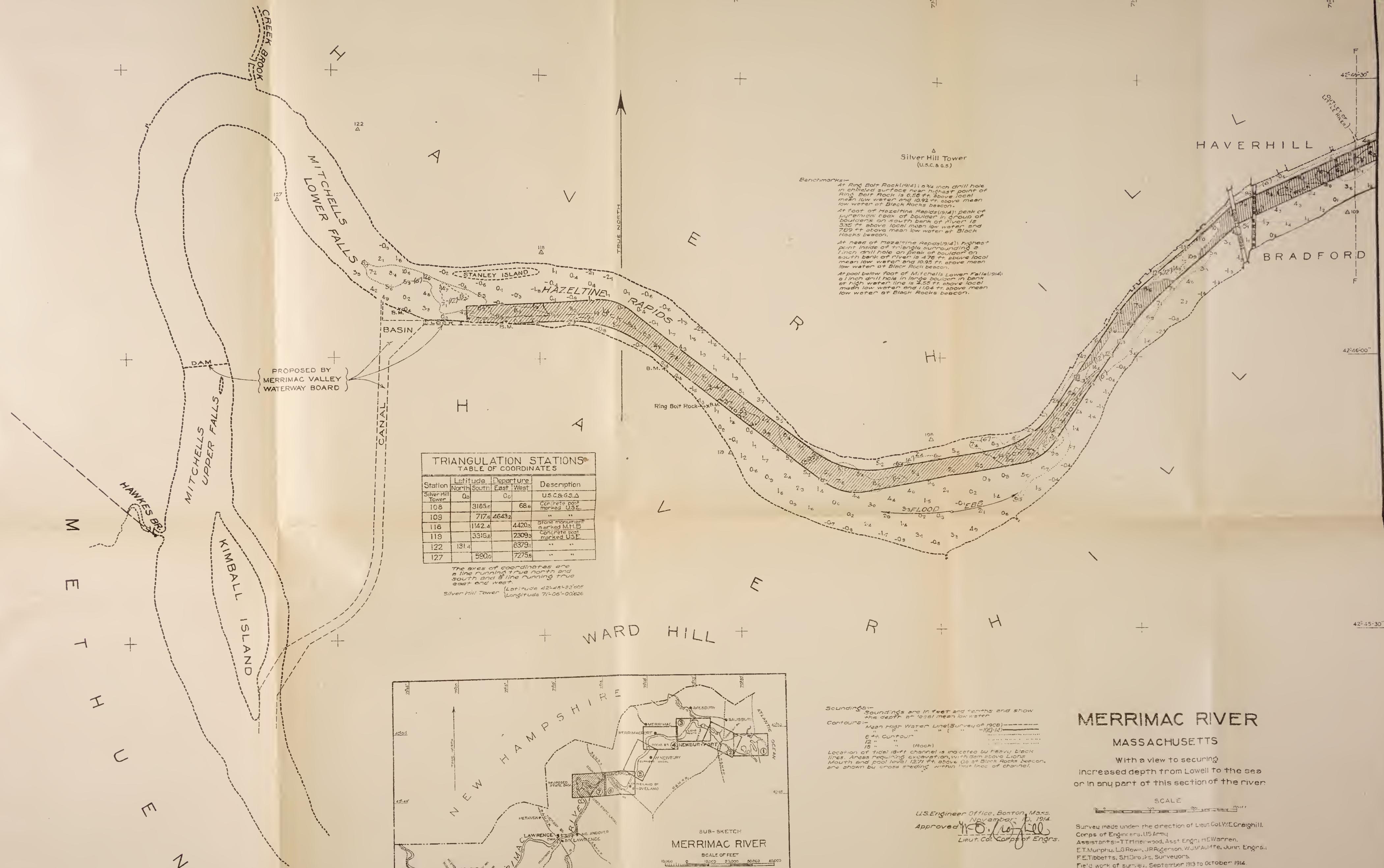


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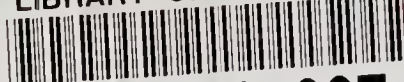
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